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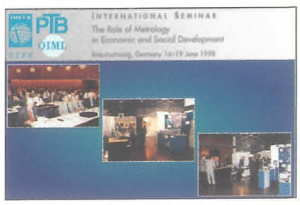

SEMINAR: THE ROLE OF METROLOGY IN ECONOMIC AND SOCIAL DEVELOPMENT

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OIML **Editorial**

Matters of Strategy

This issue of the OIML Bulletin is the stepping stone between two key events in the life of our Organization: the International Seminar on *The Role of Metrology in Economic and Social Development*, Braunschweig (June 1998) and the 33rd meeting of the International Committee of Legal Metrology, to be held in Seoul at the end of October.

We have devoted a large portion of this Bulletin to the Braunschweig Seminar; there is therefore no need to say more about it in this Editorial, except to highlight the tremendous success of the event, to confirm that it will certainly influence future international cooperation in metrology, and to reiterate our gratitude to the German Authorities and to the PTB for their impressive efficiency in preparing and organizing the Seminar.

At the time of writing, it is not possible to predict what decisions will be made at the 33rd CIML meeting; one can however foresee that two major (and interconnected) items will constitute the core of discussions.

Firstly, the CIML will have to consider the outputs of the Seminar and discuss how to implement the conclusions drawn in order to increase the role of the OIML in the economic and social development of our society. This may include a reorientation of the activity of the OIML Development Council (with closer links with, for example, the *Convention du Mètre* and ISO); an acceleration in the implementation of accreditation procedures in legal metrology (in close cooperation with ILAC and IAF); thoughts concerning the optimal extent of application of legal metrology controls; increased involvement in the elimination of technical barriers to trade (the recent granting to the OIML of Observer status by the WTO/TBT Committee will certainly facilitate this kind of activity), and so on.

Secondly, the CIML will examine (and hopefully endorse) the Study prepared by Knut Birkeland, CIML Immediate Past President, analyzing the role of metrology and legal metrology in today's and tomorrow's society, and suggesting new orientations in OIML activities in order to better suit new trends and developments.

The publication of this report and the making of decisions concerning the relevant role of the OIML should be concluded as rapidly as possible following the CIML meeting and communicated to OIML Members and other international and regional bodies concerned. In this connection, it should be noted that the CIPM has just issued a report entitled *National and International Needs Relating to Metrology* which focuses on the role of the BIPM. The metrology community will therefore soon be in a position to evaluate the complementary (but not contradictory) views of the two intergovernmental metrology bodies concerning the most advisable developments for metrology and legal metrology at international, regional and national levels. ■

BIML

LOAD CELLS

Creep and creep recovery response of load cells tested according to US and international evaluation procedures

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Abstract

The 60 min creep data from National Type Evaluation Procedure (NTEP) tests performed at the National Institute of Standards and Technology (NIST) on 65 load cells have been analyzed in order to compare their creep and creep recovery responses, and to compare the 60 min creep with creep over shorter time periods. To facilitate this comparison the data were fitted to a multiple-term exponential equation, which adequately describes the creep and creep recovery responses of load cells. The use of such a curve fit reduces the effect of the random error in the indicator readings on the calculated values of the load cell creep. Examination of the fitted curves show that the creep recovery responses, after inversion by a change in sign, are generally similar in shape to the creep response, but smaller in magnitude. The average ratio of the absolute value of the maximum creep recovery to the maximum creep is 0.86; however, no reliable correlation between creep and creep recovery can be drawn from the data. The fitted curves were also used to compare the 60 min creep of the NTEP analysis with the 30 min creep and other parameters calculated according to the Organisation Internationale de Métrologie Légale (OIML) R 60 analysis. The average ratio of the 30 min creep value to the 60 min value is 0.84. The OIML class C creep tolerance is less than 0.5 of the NTEP tolerance for classes III and III L.

1 Introduction

For the past five years the Force Group of the NIST Automated Production Technology Division has been performing load cell testing according to the National Type Evaluation Program (NTEP) as specified in the National Conference of Weights and Measures Publication 14 [1]. These tests, which at NIST are performed using primary force standards, determine certain metrological characteristics of load cells submitted by load cell manufacturers desiring to certify their load cell families as compliant with accuracy class requirements specified in NIST Handbook 44 [2].

The NTEP testing is performed with the load cells enclosed within environmental chambers designed to control the temperature of a load cell, its cable, and mounting fixture while calibrated forces are applied by deadweights. The metrological characteristics that are determined by NTEP testing include load cell linearity, hysteresis, repeatability, temperature effect on minimum dead load output, and creep, all evaluated over a temperature range of –10 °C to 40 °C.

This paper summarizes the results of analyses of the creep responses obtained from load cells tested at NIST. As described in detail in the next section, load cell creep is the difference between an initial response after a force change and the response at a later time. The purposes of the analyses presented herein were: (1) to determine how the creep response (which follows the sudden application of force) compares to the creep recovery response (which follows the sudden release of force); and (2) to compare the creep results from the NTEP procedure with those from the corresponding international Recommendation, OIML R 60 [3]. The NTEP and OIML R 60 specifications, while similar, have significant differences.

Editor's note:

This paper was first published in the Journal of Research of the National Institute of Standards and Technology, Volume 102, Number 3, May–June 1997 [J. Res. Natl. Inst. Stand. Technol. 102, 349 (1997)].

The BIML is grateful to the Editors of the Journal for granting permission to reproduce the article.

2 Load cell creep response

When the applied force acting upon a force transducer, such as a load cell, is changed rapidly to a new level and then remains constant, the force indicating system of the transducer yields a value that drifts, or creeps, with time before reaching equilibrium (providing that the transducer is sufficiently well-behaved to reach a stable value). As described by Pontius and Mitchell [4], this creep is largely attributable to thermo-elastic effects: the adiabatic heating and cooling of elastic load supporting elements within a load cell as they undergo deflection in response to changes in the applied force. A rheological model for load cell behavior by Mitchell and Baker [5] shows that the load cell output following a sudden application (or release) of force can be described as a function of time by

$$r = a_0 + \Sigma a_i \, e^{-b_i t} \qquad (1)$$

where r is the load cell output, or response, t is time since the force application, and a_0 is the equilibrium response as t becomes very large. The number of significant terms depends on the number of significantly different contributors of thermo-elastic effects; the values of the coefficients a_i and the time constants b_i depend on the complex interactions of the load supporting elements (their associated local adiabatic sources/sinks and heat flow parameters), the strain gauges and adhesives, and the thermal compensation and other elements in the electrical network. In addition, the values depend upon the loading history of the transducer, such as the period of time since the previous incremental change in applied force, and the magnitude and direction of this change. The coefficients may be of either sign; the time constants are always positive.

For most force measurement applications, the user of a load cell assumes a one-to-one correspondence between the applied force and the load cell indicator reading. Thus the time variation in the response due to creep, represented by the summation in (1), is a source of error in the determination of the applied force. A correction for creep is possible if the creep characteristics of the load cell are known and the time between the application of force and the reading of the indicator is controlled. Typically, the magnitude of the creep is a few hundredths percent of the applied load; the time before equilibrium may vary among load cells from minutes to hours.

For commercial weighing applications in the United States and many other countries, creep is controlled through tolerance limits that load cell manufacturers must meet for certification. The National Conference of Weights and Measures limits the 60 min creep for load cells being tested for NTEP certification to a tolerance that is equivalent to about 0.03 % to 0.05 % of the applied load (90 % to 100 % of cell capacity), depending upon classification parameters. The OIML limits the 30 min creep for R 60 class C (the class which most closely corresponds to the current NTEP classes) to about 0.007 % to 0.035 % of the applied load (also 90 % to 100 % of capacity). In addition, R 60 limits the allowable creep that occurs from t = 20 min to t = 30 min to about 1/5 the value of the 30 min creep tolerance. The NTEP certification procedure accepts a return-to-zero creep test, denoted as creep recovery in this paper, in lieu of a creep test if test equipment limitations make the creep test impractical. The OIML procedure does not accept such a substitution; however, it requires a measurement of the minimum load output return (MLOR), which is the change in the minimum load reading before and after the 30 min application of a capacity load. The OIML class C tolerance for MLOR ranges from 0.005 % to 0.025 % of the applied load (90 % to 100 % of capacity).

It is the comparison of creep and creep recovery, as well as the 60 min creep with creep over shorter time periods, that this paper addresses. It is beyond the scope of this work to predict the actual values of the equilibrium response a_0, the transient coefficients a_i, or the time constants b_i in (1) for any particular load cell from its structural dimensions, the mechanical, elastic and thermal properties of its components, and the characteristics and assembly of the elements of the strain gauge bridge network.

3 NTEP creep test procedure

All creep test data used for the comparisons described above were performed at NIST according to the procedure given in the NTEP specification [1]. Three of the six NIST deadweight machines were used to perform the tests described herein. These three machines have capacities of 498 kN (112 klbf), 113 kN (25.3 klbf), and 2.2 kN (500 lbf). These machines, having weights and loading frames made of stainless steel, are described in detail in [6] and [7]; therefore, only a short description of the machines is given below. The combined standard uncertainty (estimated standard deviation) in the applied forces due to uncertainties in the adjustment of the weights and variations in air density is 0.0005 % of the nominal applied force.

The 498 kN deadweight machine, shown schematically in Fig. 1, utilizes two weight stacks: a large stack consisting of ten weights, each of which are adjusted to produce a force of 44.48 kN, and a small stack of nine weights each adjusted to produce a 4.448 kN force. The loading frame, which constitutes the machine's mini-

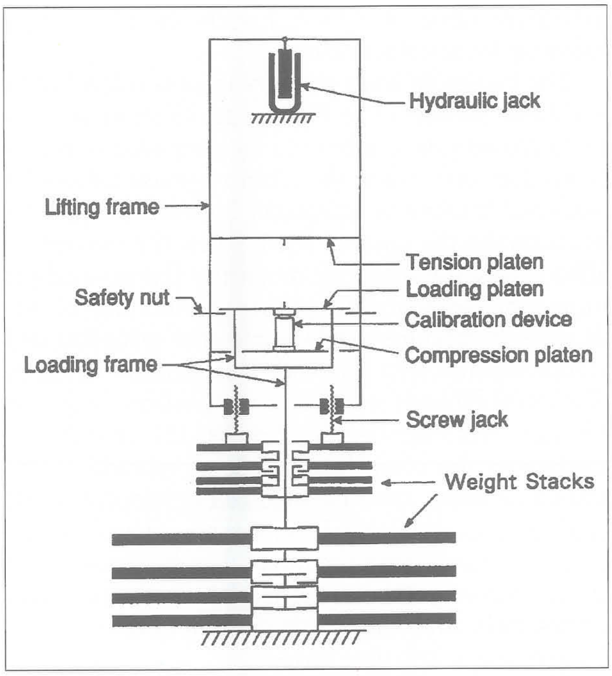

Fig. 1 Schematic diagram of the NIST 498 kN (112 klbf) deadweight machine

mum load, produces a calibrated force of 13.34 kN. The large weights are applied sequentially by raising the lifting frame with the hydraulic jack, thus raising the loading frame as the lifting force acts through the force transducer. The small weight stack is operated independently of the large weight stack, with the small weights applied by screw jacks which lower them sequentially onto the loading frame. The total applied force is thus due to the sum of the weight of the loading frame and the weights from the two stacks being borne by the loading frame.

The 498 kN machine has been fitted with an auxiliary hydraulic jack to accomplish the transfer of the loading frame, loaded with deadweights equivalent to the load cell capacity, onto the loading point of the cell within one second or less. This enables the loading time requirements of the NTEP creep test to be met, overcoming the time limitation otherwise imposed by the sequential weight-lifting mechanism of this machine. On the two smaller machines, built-in mechanisms to raise or lower the weight frame serve this same purpose.

The 113 kN deadweight machine, shown schematically in Fig. 2, utilizes eleven weights in graduated increments adjusted to produce forces from 444.8 N to 22.24 kN. The loading frame generates a minimum force of 1779 N. Each weight can be applied to the loading frame independently of the other weights by hydraulic cylinders which compress the springs which otherwise support the weights in an unloaded position. A pneumatically operated stabilizing mechanism has been installed to enable these weights to be changed without excessive swinging; thus the original operational limitation of return-to-zero loading, as described in [7], has been overcome, permitting the monotonically ascending and descending force sequences required by NTEP.

The 2.2 kN deadweight machine is schematically similar to the 113 kN machine, and has eight weights in graduated increments to produce forces from 22.24 N to 889.6 N. The loading frame generates a force of 44.48 N. The weights are applied independently of each other to the loading frame; the actuation, originally by manual operation, is now accomplished by means of pneumatic cylinders. A stabilizing mechanism has been installed which is similar to that of the 113 kN machine.

Environmental chambers for the three machines listed above have been specifically constructed for NTEP testing, providing for thermal isolation of a load cell and any associated fixture from the machine frame

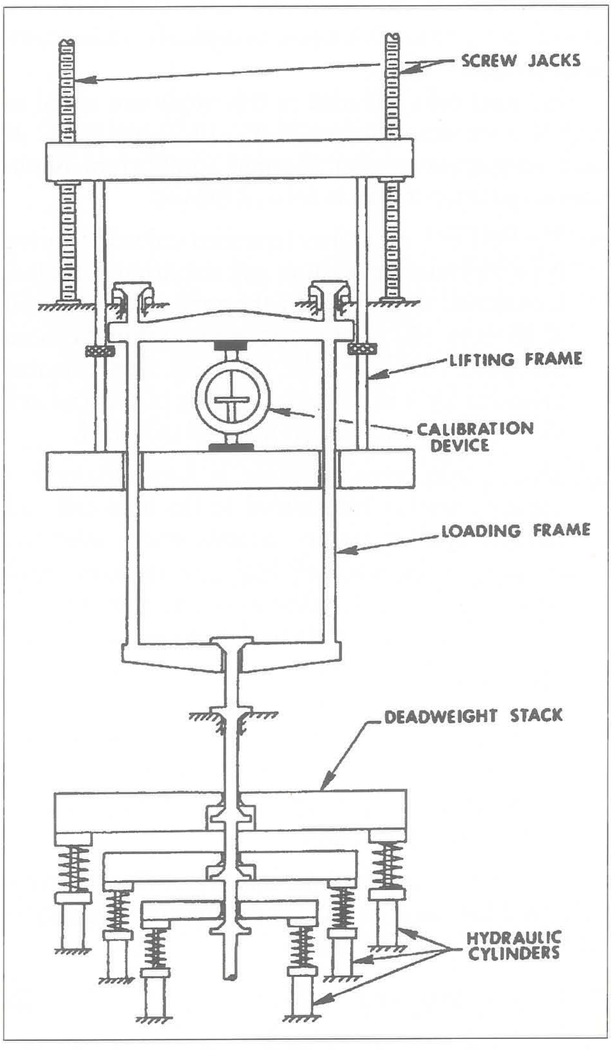

Fig. 2 Schematic diagram of the NIST 113 kN (25 klbf) deadweight machine

while calibrated forces, generated by the deadweights, are applied. For the two smaller machines, separate chambers are available to provide for either compression or tension loading. Since large capacity tension devices are rarely submitted for NTEP certification, the chamber for the larger machine has been designed for compression loading only. Heating and cooling is done through computer-controlled bath units, and several sensors allow for digital input of air temperature, surface temperatures of the load cell body and loading blocks, and the barometric pressure. All electrical control functions for the deadweight machines are interfaced to allow computer control of the weight applications (while still maintaining the original manual control capability). The load cell output is sampled by an 8 1/2-digit digital multimeter operating in voltage-ratio measurement mode. The instrumentation and algorithms for implementing automated control of the deadweight machines, voltage-ratio indicators, and environmental chambers have been described by Yee [8]. These automated systems make it possible to perform the NTEP tests, each involving several temperature changes, completely under computer control.

The load cells included in this study are tested at each of three temperatures: 20 °C, –10 °C, and 40 °C. At each temperature, after thermal equilibrium is obtained, the creep testing is done as follows:

(a) The load cell, which has remained unloaded during the temperature transition and stabilization period, is exercised three times by the application of a load of 90 % to 100 % of capacity and returned to an unloaded condition; the load cell then remains unloaded for 1 h; an initial reading of the load cell indicator is taken with the load cell unloaded.

(b) The 60 min creep response is then obtained: a capacity load is transferred to the load cell and remains applied; twenty seconds later a reference reading of the load cell indicator is taken, with subsequent readings taken at one minute intervals for 60 min (two additional readings are taken during the first minute).

(c) At NIST, the creep recovery, or return-to-zero, response is then obtained, by unloading the load cell and taking readings in the same time sequence as was done for the creep response. (Creep recovery is not required by NTEP.)

For NTEP evaluation, the maximum 60 min creep, expressed here as a fraction of the maximum indicator reading, is calculated from

$$C = (r_{max} - r_{ref})/(r_{ref} - r_0) \qquad (2)$$

where r_0 is the initial unloaded reading, r_{ref} is the 20 s reference reading, and r_{max} is the reading that gives the maximum value of $|r_n - r_{ref}|$; r_n is the n^{th} reading following the reference reading.

The maximum creep recovery value is calculated in a similar manner. The NTEP specification permits creep recovery data to be used for evaluation in lieu of creep data only when the creep response cannot be measured because of equipment limitations. This was occasionally the case at NIST when the movement afforded by the load cell mounting fixture made it impossible to maintain proper positioning of the deadweight machine weight frame after unloading and reapplying the creep test load. This problem has been eliminated through redesign of the auxiliary hydraulic lift that was installed on the 498 kN machine to implement the creep loading. Some manufacturer's testing facilities, used for load cell development and production quality control, apply forces that are generated by hydraulic pressure rather than by deadweights; a creep recovery test must be used since such a system cannot maintain a sufficiently uniform force to test for creep over a 60 min time period.

The creep and creep recovery data obtained at NIST by the procedure described above make it possible to directly compare the load cell creep and creep recovery behavior.

4 Creep response curve-fitting

Procedure

In order to facilitate comparisons such as between creep and creep recovery and between 60 min and 30 min creep values, a nonlinear model, having the form of (1), was fitted by a least-squares method to the data for each response. In addition to yielding each response in a form that can be readily evaluated, this approach minimizes the effect of the random error inherent in the indicator readings, as discussed later in section 5.2. In the earlier work that originally presented the creep response model [5], such curve-fitting was done by means of an optimization search algorithm [9] run on a mainframe computer. In the present work, a data analysis program developed at NIST [10–12] was used to perform the curve-fitting.

Plots of typical creep and creep recovery data for the same load cell for a single temperature are shown in Fig. 3 together with the fitted curves. The time $t = 0$ on the horizontal axis represents the instant that the creep test load is applied (for the creep response) or released (for the creep recovery response). The creep recovery data are displaced 60 min earlier in time in order to superimpose the curves. The first data point shown in the figure represents the 20 s reference readings for both the creep and creep recovery responses, plotted

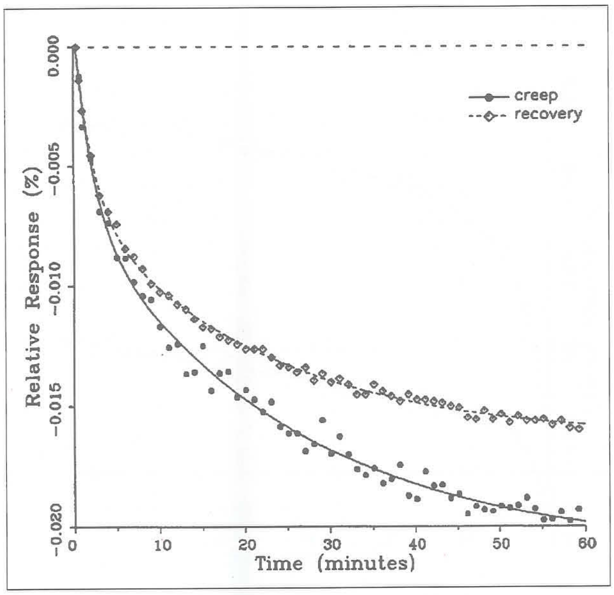

Fig. 3 Creep response and creep recovery response of a shear-beam load cell of capacity 17.8 kN; temperature: 19.6 °C

together on the baseline. The ordinates of the following points give the drift, or change, in the indicator readings relative to the reference point expressed as a percentage of the full load reading; i.e.:

$$Y_n = 100\,(r_n - r_{ref})/(r_{ref} - r_0) \qquad (3)$$

where Y_n is the ordinate of the n^{th} data point following the reference point in the creep response shown in Fig. 3, and r_n , r_{ref} and r_0 are the same as defined following (2).

The ordinates for the creep recovery response are calculated similarly, but have an additional factor of –1 incorporated into (3), thus allowing the creep and creep recovery to be directly compared in the same graph quadrant. Thus, a negative slope for the creep response, as seen in Fig. 3, represents a load cell reading that is decreasing with time (i.e., indicating a lessening load), while the same negative slope for the creep recovery response represents a load cell reading that is increasing with time.

The smooth solid curve shown in Fig. 3 is the fitted curve for the creep response relative to the 20 s reference point reading; it is given by

$$y = 100\,(r - r_{ref})/(r_{ref} - r_0) \qquad (4)$$

where r is the least-squares fit of (1) to the measured creep readings, limited here to two exponential terms. Thus r is given as a function of time t as

$$r = a_0 + a_1 e^{-b_1 t} + a_2 e^{-b_2 t} \qquad (5)$$

The fitted curve for the creep recovery response, shown with the broken line in Fig. 3, incorporates a factor of –1. The fitted curves are plotted here over a time period from 20 s to 60 min. Most of the curve-fitting calculations are limited to two exponential terms; a few, as discussed in the next section, incorporate three exponential terms.

5 Results

5.1 Demonstration of fitted curves

A number of creep and creep recovery responses, each superimposed with a plot of the equation generated by the least-squares fit, are shown in Figs. 4 to 9. The plots shown were selected to illustrate the great variation in the shapes of the responses realized among load cells. The degree to which the computed curves describe the actual data indicates that (1) is an adequate representation of load cell creep response. These figures represent a small portion of the 195 creep-creep recovery response pairs that have been fitted to (1); agreement for the cases that are not shown is, in general, as good or better than that shown in Figs. 3 to 9.

The fitted curves shown in Fig. 5 are calculated from three exponential terms in the summation in (1). This curve shows a very rapid initial transient; for such cases three terms are usually necessary to adequately describe the curve. The curves for the other figures are all generated from fits with two exponential terms. If the initial transient has a time constant of more than one minute, it was found that specifying a three-term fit results in a curve that essentially retraces the curve for a two-term fit.

The adequacy of the model defined by (1) in characterizing the creep response was judged primarily by visually comparing the data to the fitted curves. For those cases in which the random "scatter" of the points about the curve is low, the deviations are too small to be of relevance to the comparisons between creep and creep recovery being made in this study. For those cases in which the random variation is large, a plot of the residuals with time does not show any structure that would indicate that a mathematical model different from (1) should apply to these cases. The early portion of the curves for load cells having rapid initial creep transients could be better fit if more readings had been taken in that region.

No clear correlation between the load cell characteristics (type of construction, compression or tension loading mode, or cell capacity) and the shape of the creep response (direction of creep, fast or slow time

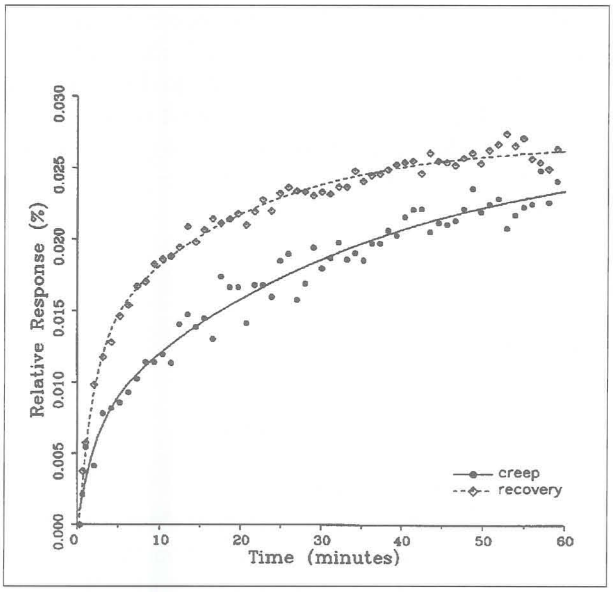

Fig. 4 Creep response and creep recovery response of a single-point load cell of capacity 490 N; temperature: –8.9 °C

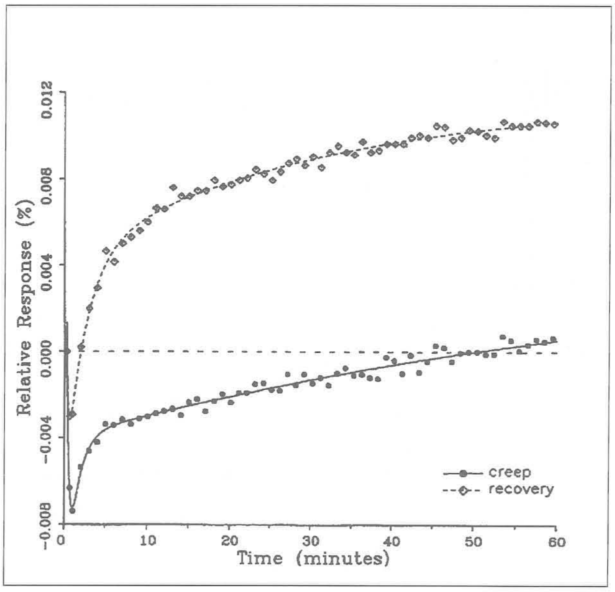

Fig. 5 Creep response and creep recovery response of a canister load cell of capacity 445 kN; temperature: 19.8 °C

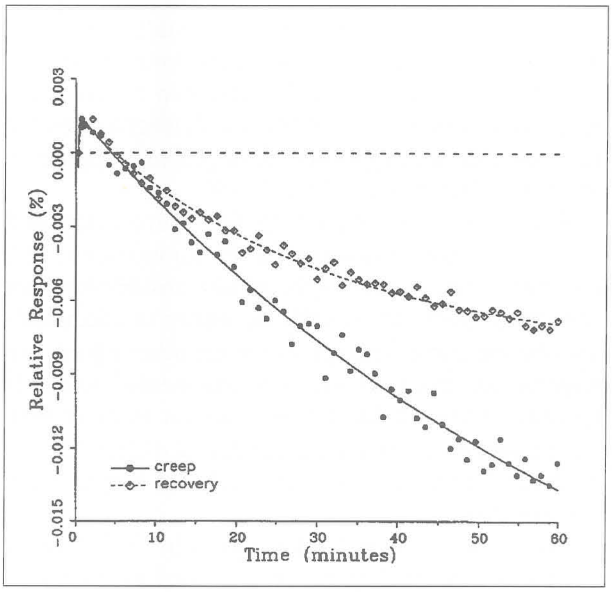

Fig. 6 Creep response and creep recovery response of a shear-beam load cell of capacity 1.47 kN; temperature: 40.1 °C

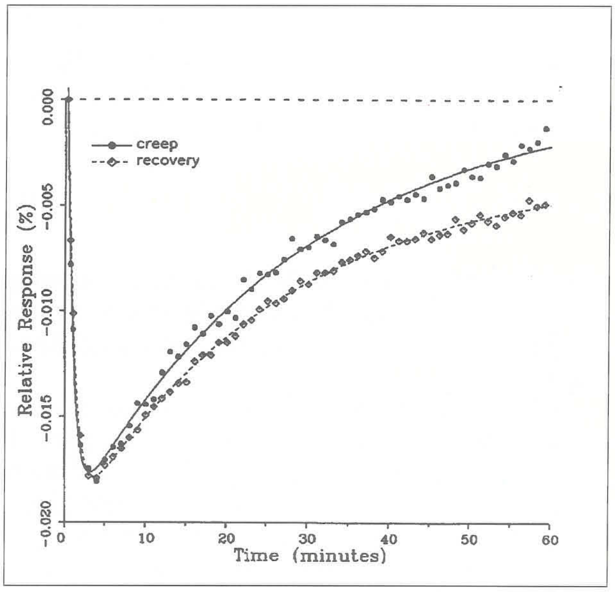

Fig. 7a Creep response and creep recovery response of a shear-beam load cell of capacity 22.4 kN; temperature: 19.9 °C

constants, initial transient) is apparent from the measurements included in this study. In fact, significantly different creep responses are often seen in the same load cell at different temperatures. Figures 7 to 9 show such variations in the creep response with temperature for each of three load cells. The creep response is thus seen to be too complex to be generalized with simple rules of thumb. Analytical modeling tools, such as finite-element analysis, may be of value in predicting the creep response from a particular load cell's design parameters.

5.2 Random error reduction

The use of the curve-fitting procedure enables a more accurate determination of the magnitude of the load cell creep by reducing the contribution of the random error in the indicator readings. For a device being evaluated on whether its creep response meets or exceeds specified tolerance limits, this serves to ensure that it is the actual device characteristic, rather than the random error in the measuring technique, that is being evaluated.

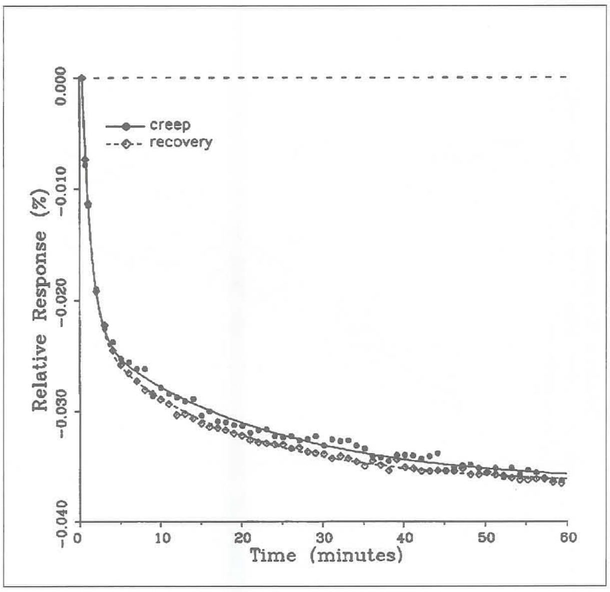

Fig. 7b Same as for Fig. 7a but at a temperature of –9.6 °C

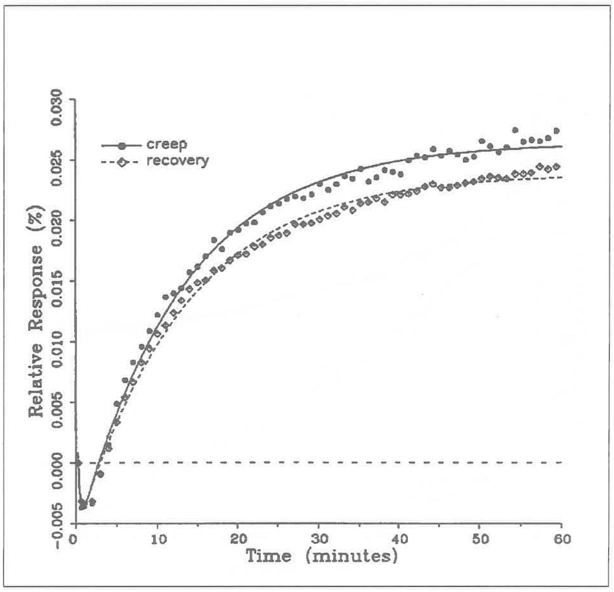

Fig. 7c Same as for Fig. 7a but at a temperature of 39.6 °C

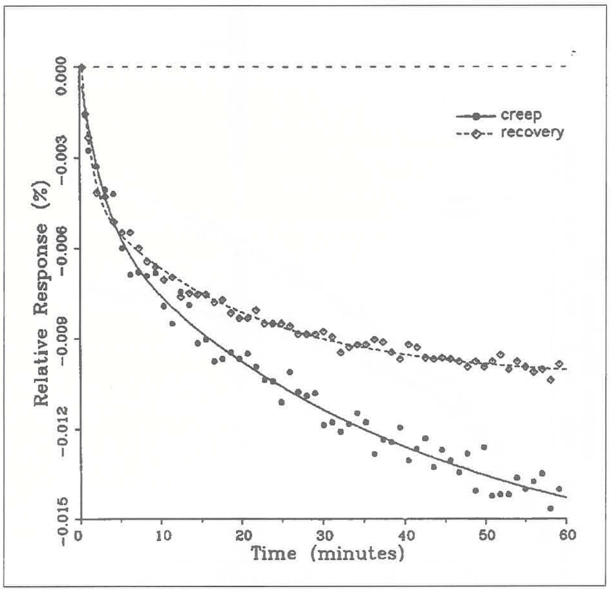

Fig. 8a Creep response and creep recovery response of a shear-beam load cell of capacity 2.22 kN; temperature: 20.0 °C

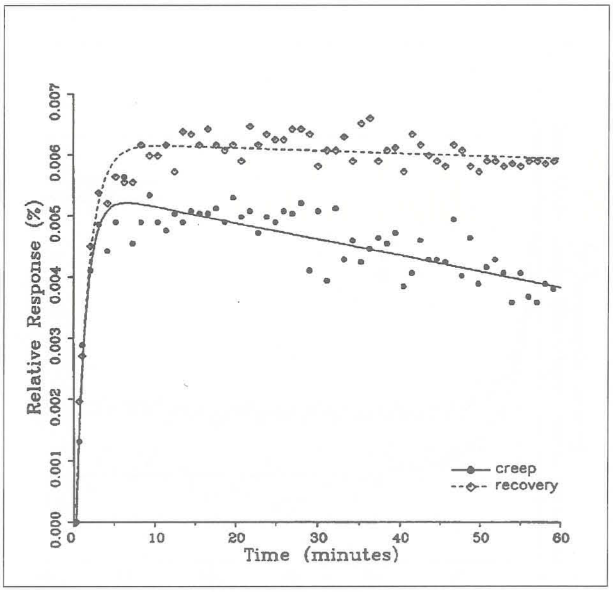

Fig. 8b Same as for Fig. 8a but at a temperature of –9.9 °C

As can be seen from (2), the creep value C used for NTEP evaluation is computed from two data points: the reference point at t = 20 s, giving r_{ref} , and the point of maximum creep, giving r_{max}; thus, C will be uncertain by the combined uncertainty of both points. Figures 10 to 13 illustrate how this evaluation method can result in an unrealistically elevated value of C. For example, the single high reading at the 47 min point in Fig. 13 defines an NTEP creep value that more properly reflects a large random variation in the readings rather than an actual creep phenomenon. If the actual creep response is considered to be given by (1), in effect making use of all of the indicator readings r_n , the corresponding creep value C' is given by

$$C' = [r(t_{max}) - r(t_{ref})]/(r_{ref} - r_0) \qquad (6)$$

where t_{ref} = 0.33 min (20 s) and t_{max} is the value of t that gives the maximum value of $|r(t) - r(t_{ref})|$ over the time interval from t_{ref} to 60 min. The denominator, being much larger than the numerator, is not significantly affected by the random variations and is thus left in the same form as in (2).

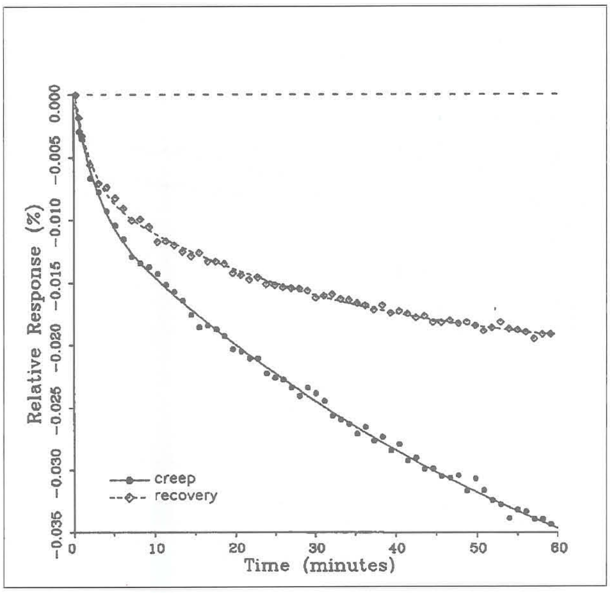

Fig. 8c Same as for Fig. 8a but at a temperature of 40.0 °C

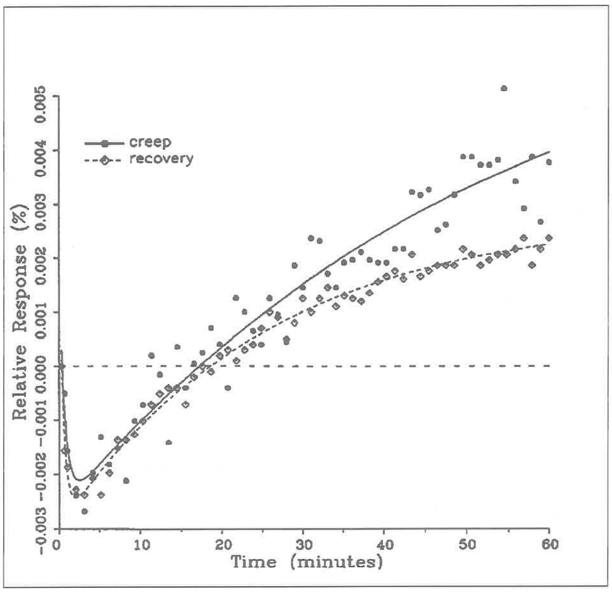

Fig. 9a Creep response and creep recovery response of a single-point load cell of capacity 981 N; temperature: 20.2 °C

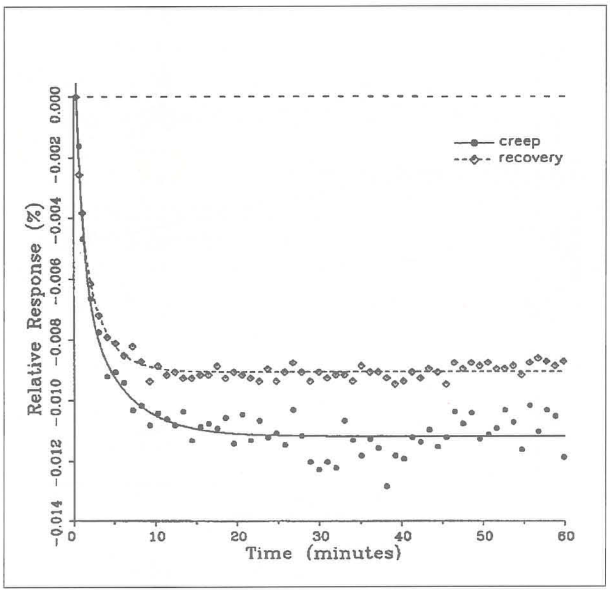

Fig. 9b Same as for Fig. 9a but at a temperature of –8.1 °C

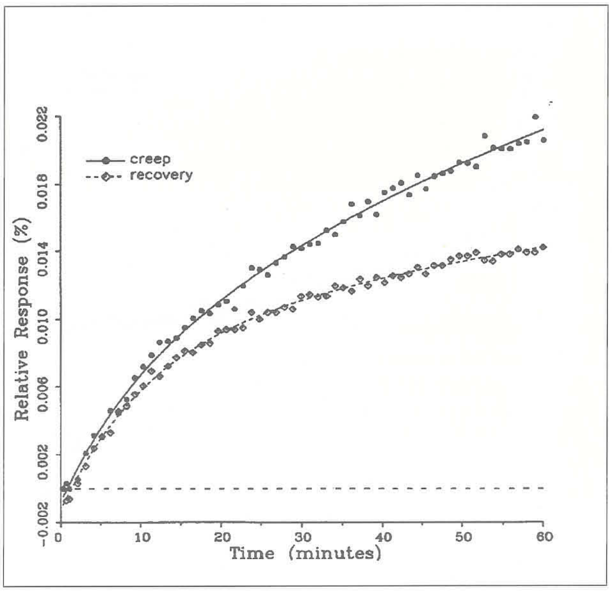

Fig. 9c Same as for Fig. 9a but at a temperature of 39.1 °C

The ratio of *C'/C* for the four creep responses in Figs. 10 to 13 is 0.76, 0.81, 0.67 and 0.59, respectively. The corresponding ratio for the creep recovery responses, which are characteristically smoother because the load cell is separated from any sources of noise associated with the loaded weight stack, is 0.94, 0.96, 0.96 and 1.04, respectively. The average value of *C'/C* for all of the creep responses analyzed in this study is 0.87, while the corresponding average value for the creep recovery responses is 0.94. Since the NTEP evaluation is generally based on the creep response, rather than the creep recovery response, use of the fitted curve to calculate the creep value would significantly reduce the effect of the random error.

The random error in the indicator readings depends on the characteristics of the indicating device, the dead-weight machine, and the load cell itself. Electrical noise, mechanical vibration, and weight movement all contribute to variations in the indicator readings. The instrumentation used at NIST to measure the voltage-ratio of the load cell strain gauge network contributes an uncertainty from random effects (expressed as a

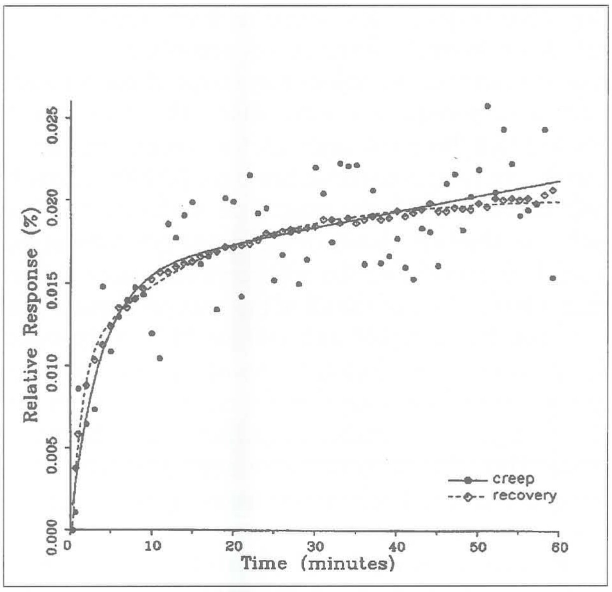

Fig. 10 Creep response and creep recovery response of a shear-beam load cell of capacity 20 kN; temperature: 19.6 °C

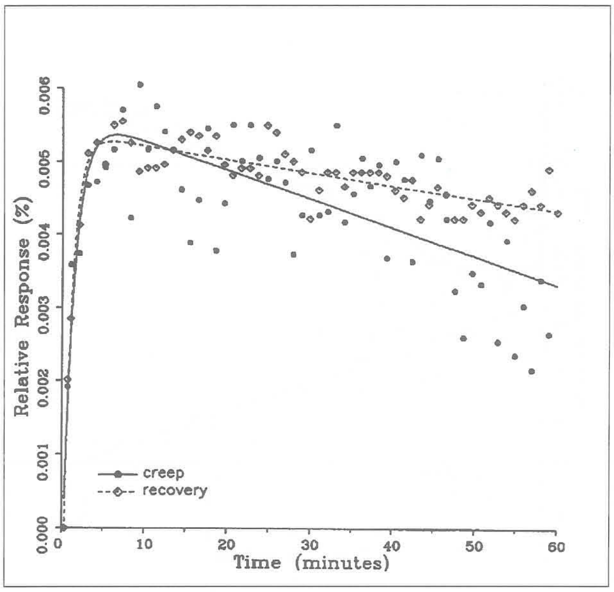

Fig. 11 Creep response and creep recovery response of a shear-beam load cell of capacity 1.47 kN; temperature: 40.1 °C

sample standard deviation) of about 0.0005 % of the reading at capacity load. In addition, some load cells exhibit more "noise" than others; inspection may reveal the "noise" to be dependent on the applied force. This effect may disappear if the same load cell is mounted in another deadweight machine capable of applying the same force. Clearly a complex load cell-deadweight machine interaction, possibly involving low level-driven harmonic oscillation, sometimes adds to the random error.

The random variation in the individual data points depends upon the indicating instrument sampling time that is chosen; for these creep measurements the sampling time is about 6 s. Increasing the sampling time may reduce the uncertainty due to random effects; however, this would involve the loss of some of the time variation information that the creep test is intended to measure. Such problems can be addressed through the use of curve-fitting calculations on readings taken continuously with relatively short sampling times.

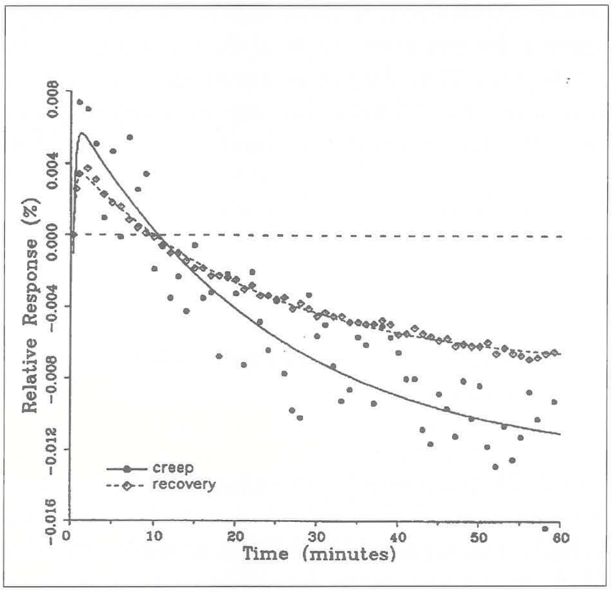

Fig. 12 Creep response and creep recovery response of a shear-beam load cell of capacity 20 kN; temperature: 39.8 °C

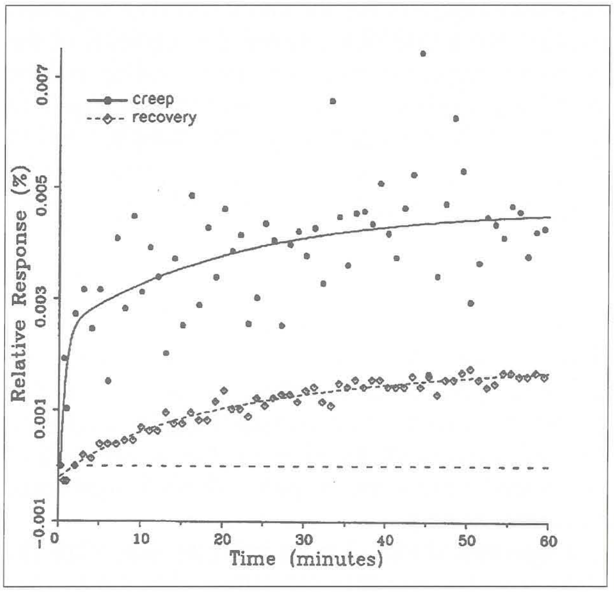

Fig. 13 Creep response and creep recovery response of a C-shaped tension load cell of capacity 22.2 kN; temperature: –10.9 °C

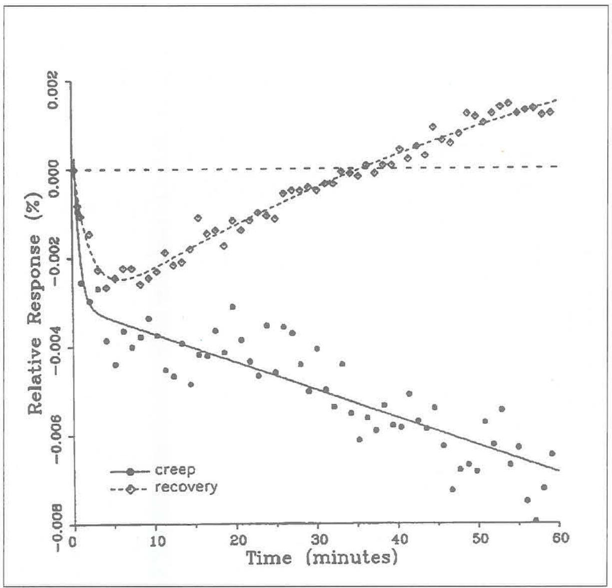

Fig. 14 Creep response and creep recovery response of an S-shaped tension load cell of capacity 2.22 kN; temperature: –10.9 °C

5.3 Comparison of creep response and creep recovery response

One purpose of this study is to determine whether the creep recovery response could be used in lieu of the creep response for design or evaluation purposes. Qualitative inspection of the creep and creep recovery pairs for all of the load cells that were tested indicates that, in 90 % of the cases, these two responses are similarly shaped; this judgment means that each term of (1) for the creep response has the same sign as the corresponding term for the creep recovery response, and that the transitions between the segments of the creep and creep recovery curves corresponding to these terms occur at about the same points in time. Figs. 3 to 12 show similarly shaped curves, for example, while in Fig. 13 the creep recovery does not have the same initial behavior as the creep response. An example of a more extreme case of dissimilar curves is shown in Fig. 14.

With one exception, the cases for which the curves are dissimilar are not correlated with any particular type of load cell construction, capacity, or test temperature. In addition, these cases generally involve only one of the three test temperatures for any one cell. The exception is one family of S-shaped tension load cells: for the five load cells tested in this family, one third of the creep-creep recovery pairs showed significant differences in shape.

Inspection of Figs. 3 to 14 indicates that, while the creep recovery response sometimes shows a greater magnitude of drift than the creep response, most often the reverse is true. If the creep values corresponding to the creep response and creep recovery response are calculated from the fitted curves according to (6), the ratio between the two values may be calculated for each pair of responses. For most cases, this ratio has a positive sign; for a few cases, as, for example, in Figs. 5 and 9a, the ratio is negative. Since the NTEP analysis is only concerned with the magnitude of the creep value, only the absolute values of the ratios are considered here. It is found that the recovery/creep ratio is less than 1.00 for 78 % of the all of the tests performed. The ratio falls between 0.60 and 1.00 for 59 % of the tests. The average of the absolute values of the recovery/creep ratios is 0.86, indicating that the creep recovery is, on the average, of a smaller magnitude than the creep value. Thus the creep response generally presents a more stringent test, when used for evaluation, than the creep recovery response.

In cases where the initial rate of creep is large, as is seen, for example, in Fig. 5, the difference between the two curves incorporates the uncertainty associated with the time of the 20 s reference reading, which appears as the first point in each of the figures. The creep test load is applied to the load cell by lowering the deadweight frame, which has already been loaded to a weight equal to the creep test load, onto the load cell by a hydraulic actuator or gear drive. The speed of the frame movement is adjusted to be slow enough to prevent shock to the load cell upon applying the load. The error in regulating the time between the load application or release and the sampling of the indicator for the reference reading may be as much as 2 s.

In the example of very rapid initial creep shown in Fig. 5, the contribution of the first exponential term in (1) is significant only for the first minute. An error of 2 s in locating the reference point here corresponds to a vertical displacement of about one-third of the distance between the minimum points of the two curves at the 1 min point. Thus the timing uncertainty cannot fully account for the difference between the creep response and creep recovery response shown in the figure. For most of the cases, which have smaller initial creep rates, the effect of the timing error is of less significance.

5.4 Comparison of NTEP and OIML creep evaluation

The NTEP procedure [1] specifies that the load cell creep be evaluated over a 60 min time period, while the OIML R 60 procedure [3] specifies a 30 min period. The OIML procedure requires two additional quantities to be determined: (1) the amount that the load cell creeps over a time period starting at 20 min and ending at

30 min after the initial reading; and (2) the minimum load output return, which is the difference between minimum load output readings before and after a maximum capacity load has been applied for 30 min.

The R 60 procedure also differs from the NTEP procedure with respect to the time interval between the force application and the initial (reference) reading: the NTEP procedure specifies this time as 20 s, whereas the OIML procedure specifies a time interval that varies with the change in applied load. For the load cell capacities used in this study, this OIML specification varies from 15 s, for capacities of less than 980 N, to 50 s for capacities greater than 98 kN. The tests conducted here used the 20 s interval specified by NTEP; however, the equation for each fitted curve can be used to estimate the load cell response at the reference time appropriate to either procedure.

Since the NIST NTEP tests involve a 60 min creep measurement followed by a 60 min creep recovery measurement, the OIML 30 min creep and 20 min to 30 min creep values can be computed from the NIST data; in addition, a minimum load output return (MLOR) at the end of 60 min of maximum load application can be computed. It is expected that, in general, the 60 min MLOR would be greater than or equal to the 30 min MLOR; thus an upper bound to the 30 min MLOR required by OIML can be computed from the NIST data. The 60 min, 30 min, and 20 min to 30 min creep values are determined from the fitted curves to (1).

These curves may be used to observe how the load cells tested here continued to creep after the first 30 min. To best compare this effect among the load cells without regard to the differing requirements for the initial time interval, let $R_{30/60}$ denote the ratio of the 30 min creep to the 60 min creep, using a 20 s reference time for each case. The 30 min creep must then be less than or equal to the 60 min creep; it is found that the average value of $R_{30/60}$ over all of the tests is 0.84. The ratio is equal to 1.00 for 15 % of the cases; $R_{30/60}$ lies between 0.9 and 0.99 for 19 % of the cases, between 0.8 and 0.89 for 29 %, between 0.7 and 0.79 for 27 %, and less than 0.7 for 10 % of the cases. When $R_{30/60}$ = 1.00, either the load cell response has reached a plateau by the 30 min point, as seen in Fig. 9b, or the maximum creep occurs in the early part of the creep response, as seen in Figs. 5, 7a, 8b and 11. Lower ratios indicate more significant creep rates in the latter half of the response, as seen in Figs. 6, 9a, 9c and 14; the corresponding values of $R_{30/60}$ for these figures are 0.56, 0.60, and 0.68 respectively.

There is a significant correlation between the OIML 20 min to 30 min creep value, which indicates how much the load creeps during this time period, and $R_{30/60}$, which indicates how much of the cell creep occurs after the 30 min point. Letting $R_{20/30}$ denote the ratio of the OIML 20 min to 30 min creep value to the OIML 30 min creep value, it is found, for instance, that for the cases where $R_{30/60}$ lies between 0.9 and 0.99, $R_{20/30}$ lies between 0.01 and 0.13 with an average value of 0.06; for the cases where $R_{30/60}$ lies between 0.8 and 0.89, $R_{20/30}$ lies between 0.04 and 0.25 with an average value of 0.12; and for the cases where $R_{30/60}$ is less than 0.7, $R_{30/60}$ lies between 0.20 and 0.66 with an average value of 0.32. Thus the OIML 20 min to 30 min creep value can, in general, identify those cases in which the OIML 30 min creep may fall significantly short of the NTEP 60 min creep.

The minimum load output return (MLOR), based on a 60 min application of maximum load, can be compared with the 60 min creep value by letting R_{MLOR} be the ratio of the MLOR value to the 60 min creep value. The average of the absolute values of R_{MLOR} is 1.05 for all of the tests conducted; however, only 43 % lie in the range of 0.9 to 1.1. These are the cases in which the creep response is monotonically increasing or decreasing with time. For example, in Figs. 3 and 4, R_{MLOR} has values of 0.99 and 1.03, respectively. In 37 % of the cases, R_{MLOR} is either less than 0.8 or greater than 1.2; in these cases the creep response is generally characterized by a large initial creep rate followed by a change in creep direction. For example, in Figs. 5 and 7a, R_{MLOR} has values of 2.1 and 0.10 respectively. Thus for almost 40 % of the time, the value of MLOR represents a different evaluation of the load cell creep behavior than is given by the maximum load cell creep.

The discussion of this section has been focused so far on how the physical parameters yielded by the NTEP and OIML creep analyses relate to each other. If the tolerances for these parameters that are currently permitted by the two programs are also considered, the actual outcomes of the NTEP and OIML evaluation procedures for the same set of load cells may be compared. This is accomplished here, making use of the fitted curves to compensate for the varying requirements for the initial reference time.

The NTEP and OIML creep tolerances depend on the load cell classification, which incorporates a specification of the maximum number of intervals, sometimes called scale divisions, into which the load cell measuring range may be divided. The number of divisions applicable for the load cells being discussed in this paper range from 3 000 to 10 000. The creep tolerance is specified in terms of the load cell verification interval v, which is the value of one scale division. The NTEP creep tolerance on the 60 min creep is dependent on class and the number of divisions, and ranges from $1.5v$ to $5v$ for the load cells considered here. The OIML tolerances for class C, the OIML class which most closely compares to the NTEP classes, are considerable tighter: for the 30 min creep, the 20 min to 30 min creep, and the minimum load output return, these tolerances are $0.74v$, $0.16v$ and $0.53v$ respectively.

Only 6 % of all of the load cells that were tested failed to meet the NTEP 60 min creep tolerance. In contrast, 62 % of the same load cells failed to meet the OIML 30 min creep tolerance, 41 % failed to meet the OIML 20 min to 30 min creep tolerance, and 79 % failed to meet the OIML tolerance for minimum load output return. All of the load cells that failed the 20 min to 30 min creep also failed the 30 min creep, and all of those that failed the 30 min creep also failed the minimum load output return. Under the current OIML tolerances, therefore, the minimum load output return presents the most severe test and the 20 min to 30 min creep presents the least severe, by about a factor of two. The NTEP 60 min creep evaluation is several times less severe than the OIML evaluations.

6 Conclusions

The multiple-term exponential equation given by (1) can be readily fitted to the creep data using curve-fitting routines in available data analysis software. Employing such a fitting procedure yields the creep response in a form that is most convenient for further analysis. Using the equation to calculate creep characteristics for evaluation testing minimizes the exaggeration of the creep value by non-creep related variation in the readings of the load cell output.

Shapes of creep and creep recovery curves are, in general, very similar. The magnitude of the creep recovery is, in general, less than the magnitude of the creep, with a difference, on the average, of more than 10 % of the creep value. For many families of load cells, the use of creep recovery data may be useful in production testing to monitor the creep performance, providing that actual creep tests representing a family do not indicate significantly dissimilar creep and creep recovery curves.

It is seen that load cells often have significant creep after the 30 min point following a load application; for example, in 37 % of the tests, the creep at 30 min is less than 0.8 of the creep at 60 min. Although the creep test of the OIML procedure does not yield creep response data beyond 30 min, the OIML placement of tolerance limits on the creep during the 20 min to 30 min period does provide a means of limiting the creep beyond 30 min.

The OIML measure of the minimum load output return (MLOR) after 30 min is not obtained by the NTEP creep test procedure. However, the MLOR after 60 min can be calculated from the NTEP data. This 60 min MLOR is seen to agree well with the 60 min creep for about half of the cases, in which the creep response is monotonically increasing or decreasing. The MLOR may significantly differ from the creep when the creep response has a large initial creep rate and a change in direction. ■

Acknowledgment

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UNCERTAINTY

Expression of uncertainty in measurements made by calibrated equipment

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1 Introduction

The revised *Guide to the Expression of Uncertainty in Measurement* [1] has been increasingly applied in many fields of measurement; a common application that requires attention is the calibration of equipment. It has been made clear that no measurement is of any worth unless it is accompanied by a statement of the degree of its uncertainty. The general procedures for calculating and reporting the uncertainty of measurement have been adequately described in the above *Guide*.

However, in addition to the uncertainties that arise through direct measurement errors, uncertainties may also arise through the calibration of the equipment which is used in the measurement. The method of estimating the uncertainties arising from the scatter of data in calibration plots is not clear to most users.

This paper therefore attempts to highlight some important aspects of calibration plots and the calculation of uncertainties arising from them.

2 Equipment calibration

It is known that over time and after prolonged use, the degree of calibration of equipment progressively diminishes, thus requiring periodic re-calibration. Generally, this is done by recording the performance of the equipment and comparing it with the performance of a more reliable piece of equipment under similar operating conditions and covering the full range of measurements it is capable of measuring. The main aim of this calibration is therefore to establish how accurate and how precise the equipment in question is. In many cases, the calibration data is presented in the form of a calibration plot. The resulting mathematical relationship of this plot is then used to correct any future measurement made by the calibrated equipment.

Even though this procedure seems simple enough and has to date been widely used, there are some pitfalls in its application that are worth clarifying.

3 Application of linear regression techniques

Calibration plots of equipment are commonly presented as a plot of *observed corrections* versus *reference equipment readings* (Fig. 1a) or as a plot of the *equipment readings* versus *reference equipment readings* (Fig. 1b) obtained under similar conditions. Examples of such plots using the data given in Table 1 are shown in Figs. 2a and 2b. In both cases, the plots are practically linear and are suitable for further mathematical processing by linear regression.

The calibration plots of the latter type described above (Fig. 1b) are more appropriate than the former type (Fig. 1a), because:

i) If the resulting calibration plot is to be described by a linear regression equation, then it is not statistically correct to plot the equipment readings on the x-axis as they inherently contain errors;

ii) The *correct value* of a future measurement made by the calibrated equipment can be directly read off such a graph;

iii) Application of linear regression techniques can provide a convenient means of estimating the uncertainty arising from the scatter of the calibration plot.

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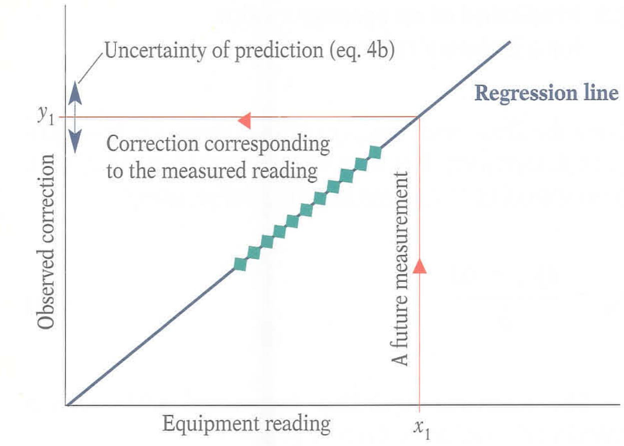

Fig. 1a *Calibration plot:*
Observed correction vs. equipment reading

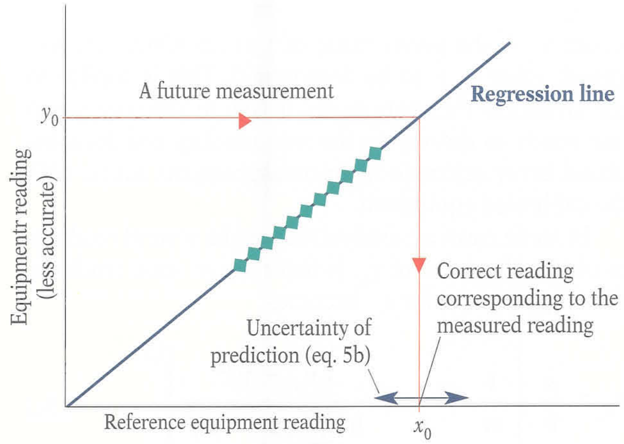

Fig. 1b *Calibration plot:*
Equipment reading vs. reference equipment reading

It must be noted that the uncertainty associated with a predicted y-value corresponding to a given x-value is different from the uncertainty associated with a predicted x-value corresponding to a given y-value. Although the calculation of the uncertainty in a predicted y-value for a given x-value has been described commonly in many standard texts of statistics [2, 3], the reverse is not common. However, the situation with regard to calculating the uncertainty of a measured value using calibrated equipment is similar to the latter case described above.

Relevant formulae for the calculation of uncertainties of predictions using linear regression are presented in this section and their use is illustrated with examples in section 4. Even though these equations may seem complex, the use of commonly available statistical software renders the calculations simple and hence their use should be encouraged.

3.1 Regression line

Linear regression, which uses the method of least squares to obtain the best-fitting straight line through the data, assumes certain conditions in its derivation. The most important of these is the assumption that the values of x are error-free, and that all errors are contained in the y-values only [2].

However in calibration, even the measurements made by the reference equipment are prone to error. But, since these errors are smaller than those of the equipment requiring re-calibration, the reference equipment values need to be plotted on the x-axis giving rise to a plot as shown in Fig. 1b. The method of obtaining the regression line and the associated error estimates of its slope and intercept are described below.

Using the method of least squares, which minimises the sum of the squares of the y residuals, the slope the regression line, b, and the intercept, a, are given by:

$$b = \frac{\sum_i \left\{(x_i - \bar{x})(y_i - \bar{y})\right\}}{\sum_i (x_i - \bar{x})^2} \qquad (1a)$$

$$a = \bar{y} - b\bar{x} \qquad (1b)$$

where ($\bar{x}$ and $\bar{y}$) represent the centroid of the data points through which the line passes; y_i and x_i denote the readings on the equipment needing correction and those of the reference equipment, respectively.

The equation of the regression line would then be:

$$y = a + bx \qquad (1c)$$

3.2 Error in slope and intercept of the regression line

The random errors associated with the slope and intercept of the regression line will determine the confidence interval of the predicted results. In order to estimate the errors in the slope and intercept, first the standard deviation (s) of the points about the regression line needs to be calculated. This is given by [3]:

$$s = \left\{\frac{\sum_i (y_i - \hat{y}_i)}{n - 2}\right\}^{1/2} \qquad (2)$$

where $\hat{y}_i$ is the value of y calculated from the regression line corresponding to an x_i value.

The standard uncertainty of the slope is then given by:

$$s_b = \frac{s}{\left\{\sum_i (x_i - \bar{x})^2\right\}^{1/2}} \tag{3a}$$

and the standard uncertainty of the intercept is given by:

$$s_a = s \left\{\frac{\sum_i x_i^2}{n \sum_i (x_i - \bar{x})^2}\right\}^{1/2} \tag{3b}$$

Both s_b and s_a have (n – 2) degrees of freedom associated with them where n is the number of data points in the regression plot.

3.3 Prediction of an average y value for a given x value

Corresponding to a given x-value, say x_1, a y-value, y_1, could be predicted from the regression equation:

$$y_1 = a + b\,x_1 \tag{4a}$$

If the aim is to predict the mean y-value corresponding to the given value of x, x_1, then the standard deviation for the prediction may be given as:

$$s_{\bar{y}_1} = s \left\{\frac{1}{n} + \frac{(x_1 - \bar{x})^2}{\sum_i (x_i - \bar{x})^2}\right\}^{1/2} \tag{4b}$$

However, if the aim is to predict a single y-value corresponding to the given x_1-value, its standard deviation is given by:

$$s_{y_1} = s \left\{1 + \frac{1}{n} + \frac{(x_1 - \bar{x})^2}{\sum_i (x_i - \bar{x})^2}\right\}^{1/2} \tag{4c}$$

If m such predictions are made, then the standard deviation of their mean is given by:

$$s_{y_1} = s \left\{\frac{1}{m} + \frac{1}{n} + \frac{(x_1 - \bar{x})^2}{\sum_i (x_i - \bar{x})^2}\right\}^{1/2} \tag{4d}$$

The standard uncertainty s_{y_1} has (n – 2) degrees of freedom associated with it.

3.4 Prediction of an average x value for a known y value

Once the slope and intercept of the regression line have been determined, it is easy to calculate an x-value, (x_0), corresponding to any measured y_0-value, using:

$$x_o = \frac{(y_o - a)}{b} \tag{5a}$$

The standard deviation associated with such a calculated x_0-value is given by [4]:

$$s_{x_o} = \frac{s}{b} \left\{1 + \frac{1}{n} + \frac{(y_o - \bar{y})^2}{b^2 \sum_i (x_i - \bar{x})^2}\right\}^{1/2} \tag{5b}$$

where y_0 is the given value of y from which the unknown value x_0 is to be determined. This is similar to the situation that commonly arises in practice when one wants to determine the true reading and its associated error estimate from measurements made with the calibrated equipment.

In some cases an analyst may make several readings to obtain the value of y_0. If there are m such readings, then the equation for s_{x_0} becomes:

$$s_{x_o} = \frac{s}{b} \left\{\frac{1}{m} + \frac{1}{n} + \frac{(y_o - \bar{y})^2}{b^2 \sum_i (x_i - \bar{x})^2}\right\}^{1/2} \tag{5c}$$

s_{x_0} has (n – 2) degrees of freedom.

3.5 Prediction errors when x-values contain errors

This situation commonly arises when one calibrates equipment against reference equipment whose measurements themselves are prone to error.

Note: The linear regression model assumes that the x-values are error-free.

Let e_i be the error in y_i-values, d_i be the error in x_i-values with a standard deviation of s_X and $y = a + bx$ be the equation of the regression line. Thus, for a given data point:

$$y_i = a + b(x_i + d_i) + e_i$$

$$y_i = a + bx_i + (e_i + bd_i)$$

If the errors in y and x, e_i and d_i are independent, then [5]:

$$\mathrm{Var}\,(e_i + bd_i) = \mathrm{Var}\,(e_i) + b^2\,\mathrm{Var}\,(d_i)$$

Thus, the combined standard deviation of y-values about the regression line, s_c, can be approximated by:

$$s_c^2 = s^2 + b^2 s_x^2 \qquad (6)$$

where s is the standard deviation given by equation 2 above.

That is, when random errors in x-values exist, they can be accounted for by the use of the combined standard deviation in place of the s in equations 4 and 5 used for the calculation of standard uncertainties of the predictions.

4 Examples of application

4.1 Calibration example in the *Guide* [1]

This example illustrates the use of the method of least squares to obtain a linear calibration curve and how the variances associated with its intercept and slope are used to obtain the standard uncertainty of a predicted correction based on a calibration curve shown in Fig. 2a. The data used in the calculations is reproduced in Table 1 from Table H6 of [1].

Fig. 2a shows a plot of the observed correction b_k vs. the measured temperature t_k. The regression equation

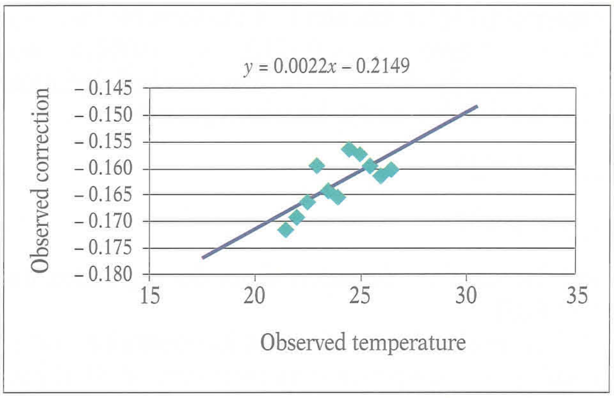

Fig. 2a *Calibration plot:* Observed correction vs. observed temperature

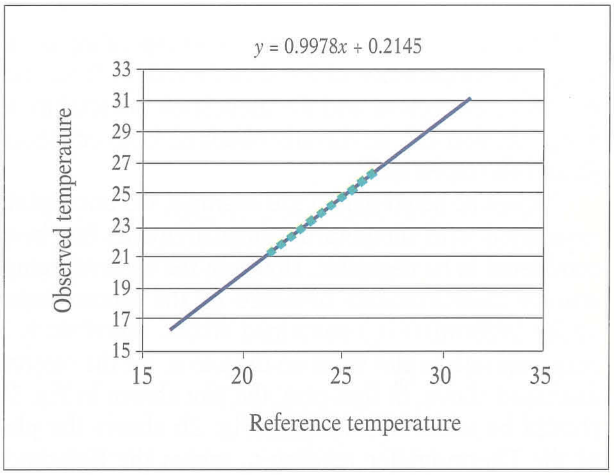

Fig. 2b *Calibration plot:* Observed temperature vs. reference temperature

Table 1 Thermometer calibration data from [1]

Reading No. (k)	Thermometer reading (t_k °C)	Observed correction (b_k °C)	Reference temp. ($t_{R,k}$ °C)
1	21.521	– 0.171	21.350
2	22.012	– 0.169	21.843
3	22.512	– 0.166	22.346
4	23.003	– 0.159	22.844
5	23.507	– 0.164	23.343
6	23.999	– 0.165	23.834
7	24.513	– 0.156	24.357
8	25.002	– 0.157	24.845
9	25.503	– 0.159	25.344
10	26.010	– 0.161	25.849
11	26.511	– 0.160	26.351

reported in [1] for this plot is of the form $b(t_k) = y_1 + y_2 (t_k - t_o)$ where $y_1 = -0.1712$, $y_2 = 0.00218$ and t_o is arbitrarily chosen as 20. The standard deviations associated with y_1 and y_2 have been given as:

$s(y_1) = 0.0029$

$s(y_2) = 0.0067$

and the standard deviation about the regression line $s = 0.0035$

The predicted correction and its uncertainty corresponding to a temperature measurement of 30 °C have been given as:

$b_{30} = -0.1494$ °C

and $U(b_{30}) = 0.0041$ °C with 9 degrees of freedom.

Thus, the *correct temperature* corresponding to an observed temperature of 30 °C is 29.850 °C. Note that the above correction and the associated uncertainty of the prediction can be directly obtained from equations 4a and 4b respectively.

It must be noted that in this example, the uncertainty associated with temperature measurements has been considered to be negligible. However, the observed temperature measurements obtained by the thermometer under calibration (t_k) contained errors, therefore it is inappropriate to plot them on the x-axis, for the reasons discussed above. In that case, the plot shown in Fig. 1b should be used. Accordingly, Fig. 2b shows the plot of the Thermometer reading t_k versus the Reference temperature $t_{R,k}$.

The regression equation and the appropriate uncertainties for this plot can be given as:

$t_k = +0.21449 + 0.9978\, t_R$

$s = 0.00349$

$s(a) = 0.01589$

$s(b) = 0.00066$

The correct temperature for a measured temperature of t_k equal to 30 °C using the calibrated thermometer can be obtained from equation 5a above while its standard deviation is given by equation 5b. It yields:

- For $t_k = 30$ °C $\rightarrow t_R = 29.8512$ °C
- The standard uncertainty of prediction = 0.0084 °C with 9 degrees of freedom.

Note: This uncertainty of prediction is considerably larger than the value obtained from the procedure reported in [1] of 0.0041 °C with 9 degrees of freedom.

4.2 Calibration of a digital thermometer [6]

This example illustrates the calibration of a digital thermometer using a platinum resistance thermometer as the reference.

In [6] the authors have demonstrated the estimation of the combined standard uncertainty for the reference standard platinum resistance thermometer by evaluating the Type A and Type B uncertainties. It has been shown that the combined standard uncertainty of the reference thermometer is 0.013 °C with 29 effective degrees of freedom. The data used in the above analysis has been reproduced from [6] and is shown in Table 2.

Table 2 Thermometer calibration data from [6]

PRT temperature reading	Digital thermometer reading
– 0.003	– 0.08
– 0.002	– 0.08
– 0.003	– 0.08
25.172	25.09
25.161	25.10
25.161	25.13
51.212	51.34
51.221	51.37
51.261	51.37
103.541	103.45
103.497	103.43
103.518	103.43
155.581	155.36
155.587	155.38
155.569	155.36
207.461	207.37
207.495	207.37
207.528	207.42
309.717	311.39
309.726	311.37
309.734	311.28

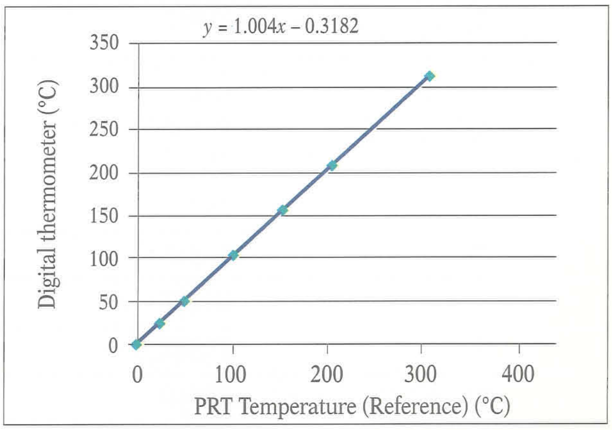

Fig. 3 *Calibration plot:* Digital thermometer

If this digital thermometer were to be used to measure an unknown temperature, then a calibration graph of the form shown in Fig. 3 needs to be used. The regression equation of this plot can be given by:

- Digital = – 0.318 + 1.004 PRT
- with the standard deviation about the regression line $s = 0.4563$

If the digital thermometer shows a reading of say, 200 °C, then the corresponding "correct" temperature shown by the PRT could be calculated using the regression equation 5a, i.e.:

Predicted temperature = 199.520 °C

Its standard deviation can be calculated by equation 5b. However, in deriving equation 5b, it had been assumed that the errors in the x-values was zero. But in this example, the reference platinum thermometer used for the calibration also contained errors with a standard uncertainty equal to 0.013 °C with 29 degrees of freedom. The standard deviation of the regression can be adjusted to incorporate the above errors using equation 6. The resulting overall standard deviation can then be used in equation 5b to arrive at the standard deviation of the unknown temperature.

The combined standard deviation is

$$s_c^2 = s^2 + b^2 s_x^2$$

$$= 0.4563^2 + 1.004^2 \times 0.013^2$$

$$s_c = 0.456486 \text{ °C}$$

The standard deviation of the unknown temperature measured as 200 °C by the digital thermometer is:

$$s_{200} = \frac{0.4565}{1.004} \left\{ 1 + \frac{1}{21} + \frac{(200 - 122)^2}{1.004^2 \times 219867} \right\}^{1/2} = 0.4714 \text{ °C}$$

The best estimate of the unknown temperature is 199.52 °C with a standard uncertainty of 0.471 °C with 19 degrees of freedom.

Note that the uncertainty of the calculated temperature is higher than the individual equipment errors due to the presence of scatter in the calibration plot.

5 Concluding remarks

In this paper, an attempt has been made to highlight some important points in using regression analysis on calibration plots, and demonstrate the correct procedure in its application. The important points stressed with regard to applying linear regression to calibration plots are:

a) The x-axis should be chosen to represent the data with least errors;

b) The prediction error of an x-value for a given y-value is different from that of a y-value for a given x-value; and

c) When the x-values contain errors they should be combined with those of y-values in order to obtain the error estimates of a prediction. ■

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SLOVENIA

Establishing appropriate metrological infrastructures in a small country with important industrial production

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Abstract

This article, which was presented by Mr. Drnovšek at the International Seminar on "The Role of Metrology in Economic and Social Development" (Braunschweig, 15–19 June 1998), describes Slovenia's metrological infrastructure.

Whilst Slovenia is considered as a "small" country in terms of the total number of measurements made, the majority of these do have to comply with relatively demanding metrological requirements.

In this respect, technical issues such as traceability and accuracy, organizational issues such as accreditation and other activities such as calibration, verification, etc. should be executed with the objective of employing finances, facilities, man power and time in the most efficient way possible.

This having been said, it is however mandatory to follow relevant European (and indeed international) guidelines and formal requirements, in order to participate on equal grounds in international markets.

1 Introduction

After a five-year transition period during which Slovenia's technical and metrological infrastructures have been progressively transformed, fundamental documents have in particular been issued designating the legal framework for the operation of the Slovenian metrology system, including:

- A Law on Metrology (Republic of Slovenia Official Gazette No. 1, 1995), defining basic metrological entities with legal and industrial fields of interest, national measurement standards, relevant relations, responsibilities etc.;
- A Law on Standardization (Republic of Slovenia Official Gazette No. 1, 1995), defining the area of standardization (and explicitly accreditation activities), and also concerning calibration and verification activities;
- A Decree defining the types of measuring instruments which are subject to mandatory type approvals and verifications;
- A Decree on units of measurements;
- A Procedure for type approvals in the field of legal metrology;
- A Decree on national standards specifying requirements for those laboratories which will provide traceability to international level for particular physical quantities and assure the dissemination to lower levels with minimal additional uncertainties, where EA (European Accreditation) accreditation or equivalent is a major requirement;
- A Public Tender Procedure for those laboratories regarded as holders of national standards, together with the appropriate evaluation process;
- A Procedure for assuring traceability of reference standards in calibration laboratories.

In order to implement internationally recognized metrological requirements, basic Slovenian metrological strategy complies with OIML Recommendations, EU legal metrology Directives and to the EA as far as the organization, technical quality and competence of calibration and test laboratories is concerned.

One of the fundamental decisions made was that rather than engaging in sophisticated research in the field of metrology, the main objective was to establish an internationally recognized traceability and quality system for particular physical quantities with an appropriate means to disseminate these quantities. Only after basic traceability has been established can improvements in measurement uncertainty and possibly in the dynamic range take place.

In this respect the SMIS (part of the Ministry of Science and Technology of the Republic of Slovenia), which is responsible for the organization of national metrology, has organized a number of seminars and workshops covering all the aspects mentioned above with the aim of informing the laboratories concerned and preparing them for the new regulations and national metrology policy which began to be implemented in 1997.

The most important message put across in all these events was that accreditation of laboratories is considered as being the sole and most objective measure of their technical competence, as opposed to the previous practice of granting authorizations based primarily on administrative requirements but which were not proven by *actual* evidence of technical competence.

2 Organizational structure of Slovenian metrology

Figure 1 shows the hierarchical organization of Slovenian metrology, with the emphasis on industrial metrology. For all metrological activities (i.e. legal and calibration or industrial), in principle one equipment facility is established at the highest level, necessarily including the appropriate quality and management systems.

One of the main characteristics of this hierarchy is that the Slovenian national standards system is organized as a *distributed* system as opposed to a *centralized* system, such a distributed system being based on transfer standards that are traceable to international level, i.e. to the laboratories where the primary standards are actually realized.

For the time being Slovenia does not envisage realizing SI units according to the definitions, if not explicitly required and justified, but on the highest level of transfer technology and disseminated with minimal additional uncertainties. The entire system is coordinated and internationally represented by SMIS, which is also responsible for the financial aspects of maintaining and providing traceability to international level for laboratories, holders of national standards and other reference laboratories.

The Slovenian metrology system is based on laboratories which perform a variety of measurement related activities, though not all of these are part of the Slovenian calibration service. As can be seen from Fig. 1, this service basically consists of the highest level laboratories, holders of national standards for basic SI units and secondary level of reference measurement standards for providing traceability for the derived units; accreditation is required for all of these.

The basic difference between the two levels is that for national standards, basic scientific research and international cooperation is required as well as providing traceability and dissemination, while for the reference standards the main requirement is to provide traceability and assure dissemination.

During their transition period (i.e. while they are still in the process of achieving accreditation), laboratories may also participate in the calibration service in order to satisfy companies' demands, in which case they remain under strict SMIS supervision.

Many other laboratories besides those within the Slovenian calibration service are also very well equipped and perform sophisticated measurements in the fields of science and technology or public services, etc., but do not have a recognized quality system equivalent to accreditation. In this case these laboratories may or may not become members of the Slovenian calibration service, depending on their degree of willingness to achieve accreditation.

The Slovenian calibration service does not have a special logo: evidence of the validity of a calibration certificate is the presence of the accreditation body's logo. But even the best measurement capabilities of laboratories which have *not* yet achieved accreditation are guaranteed neither by SMIS nor by the Slovenian accreditation service, and are the sole responsibility of each particular laboratory.

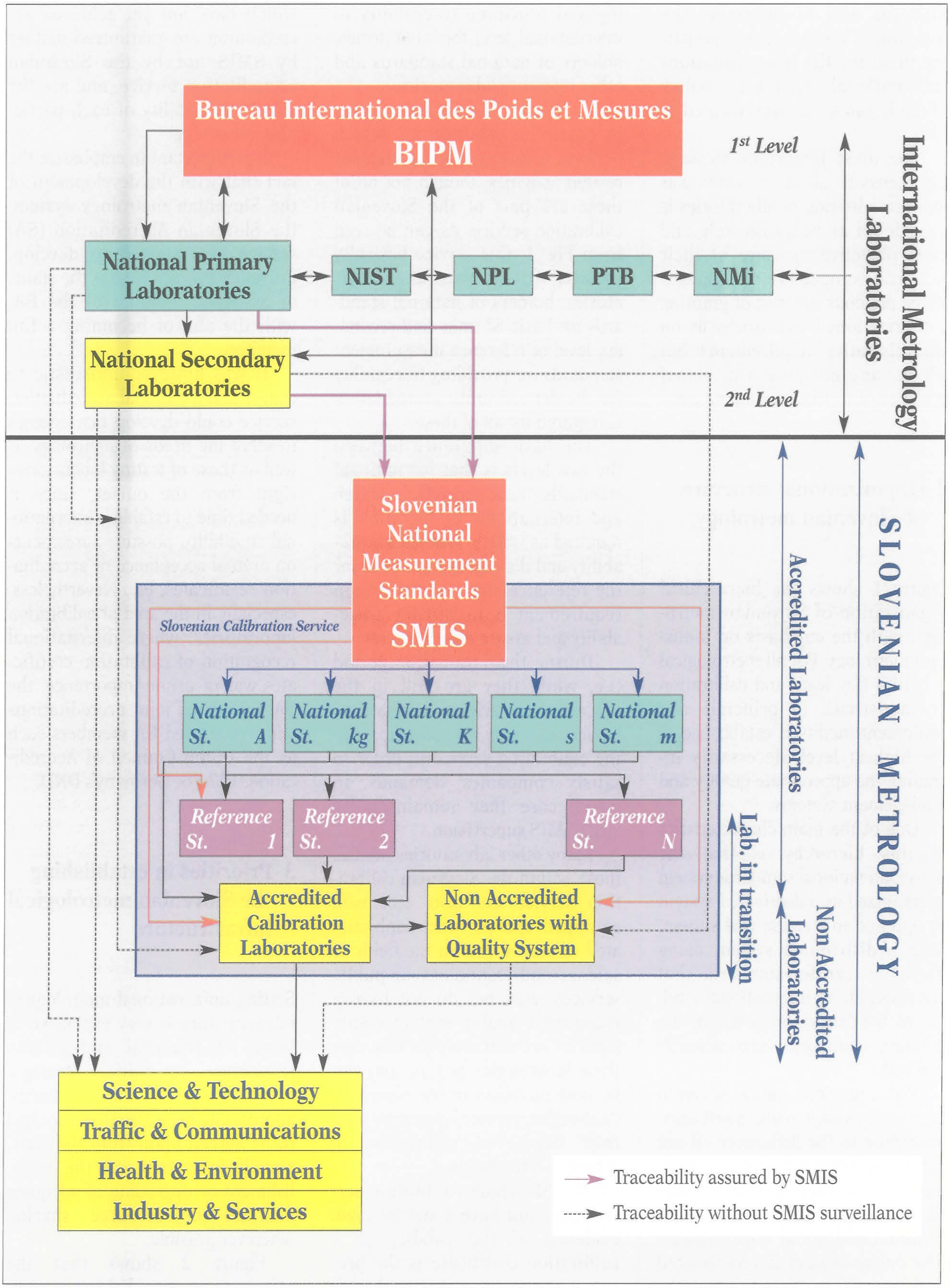
It is important to emphasize the fact that with the development of the Slovenian metrology system, the Slovenian Accreditation (SA) service also started to develop. Currently this service has the status of associate member of the EA, with the aim of becoming a full member.

It was however unrealistic to expect that a national accreditation service could develop fast enough to serve the needs of metrology as well as those of testing laboratories right from the outset, since it needed time to establish international credibility, possible agreements on mutual acceptance of accreditation certificates, etc. Nevertheless, especially in the area of calibration laboratories, where international recognition of calibration certificates was of prime importance, the SA performed joint accreditations with recognized EA members such as the Dutch Council of Accreditation (RVA) or Germany's DKD.

3 Priorities in establishing the Slovenian metrological infrastructure

Setting up a national metrological infrastructure is very expensive in terms of financial and human resources, so initial strategic planning was essential. Primarily, appropriate priorities therefore had to be agreed upon from the start; equally important was the establishment or upgrading of adequate facilities or resource sharing wherever possible.

Figure 2 shows that the priorities in establishing a metrological infrastructure in Slovenia lie at the intersection of global



Traceability chart of the Slovenian Metrology System: A distributed system based on transfer standards

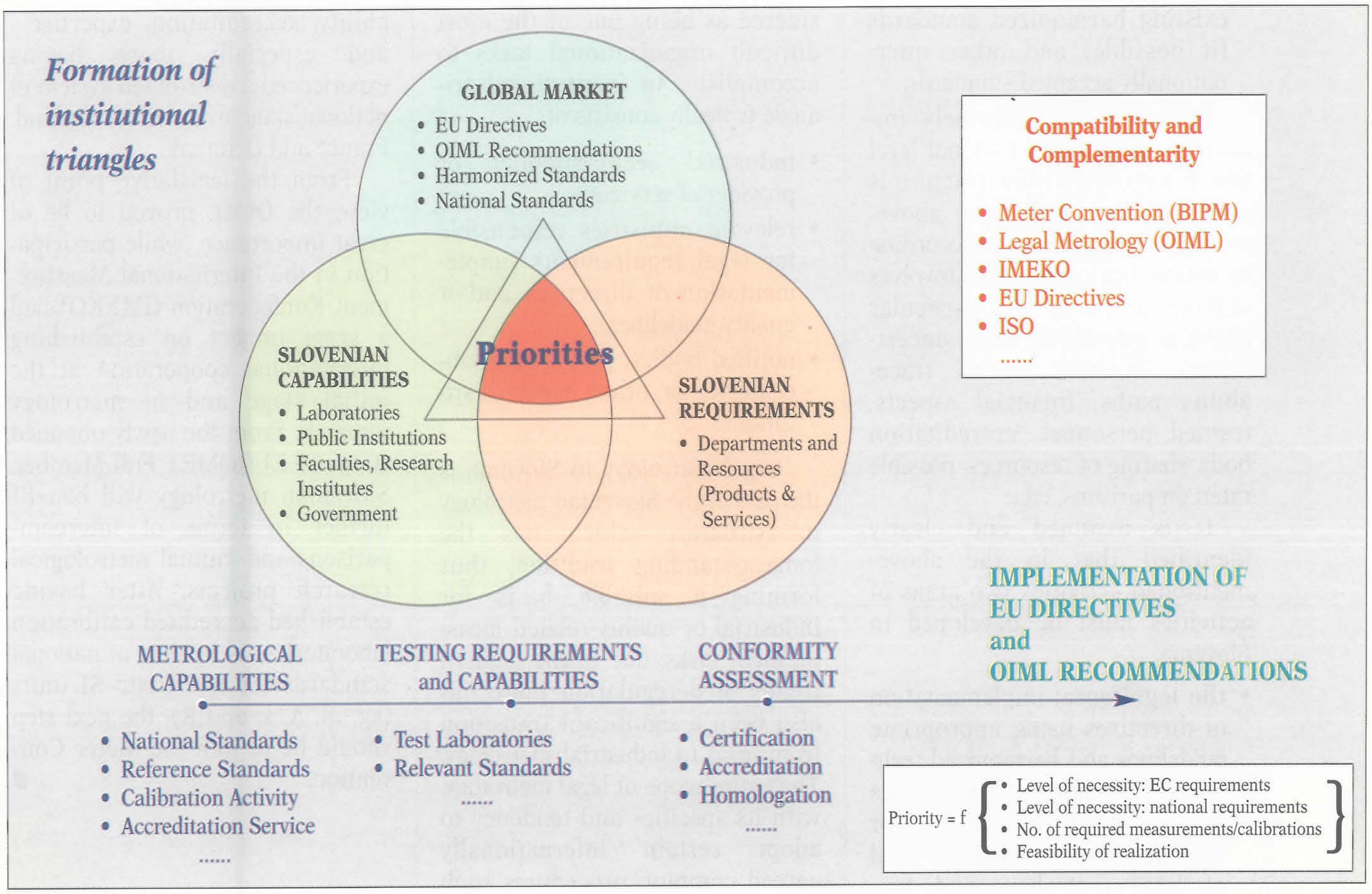


Fig. 2 Prioritizing and criteria of implementation of the Slovenian metrological infrastructure

market requirements, Slovenia's own requirements and of Slovenian capabilities. The system, together with its accredited and distributed chain of metrological laboratories, must (amongst other requirements) comply with EC legislation.

Metrology (as one of the fundamental infrastructures of modern society but one which is very often still not adequately acknowledged in emerging economies) has to play an important role in conformity assessment in order to eliminate technical barriers to trade, provide consumer and environment protection as well as assure safety and other requirements. For these reasons a metrology infrastructure is strongly related to the implementation of directives, since two of the most important elements of the New Approach directives are the essential requirements governing the characteristics of the product covered and the conformity assessment procedures required to demonstrate that a product conforms to the requirements of the directive.

When using EN 45000 series standards to assess the technical competence, independence, integrity, impartiality, etc. of notified bodies, the relationship between the criteria of the specific EN 45000 standard and the actual tasks to be performed according to particular modules has to be established. Council Decision 93/465/EEC clearly defined the general framework of the modules system, while the directives prescribe conformity assessment systems that must be used by suppliers.

Despite the highly sophisticated documentation mentioned above, there are however some questions on the level of a basic metrology infrastructure, such as traceability and uncertainty in the case of type testing, product testing, accreditation of legal metrology laboratories, etc. that should be further elaborated.

Why should metrology be considered as a foundation?

The entire chain of conformity assessment could be considered as below:

- basic metrology infrastructure (traceability and calibration);
- testing and verification (certification, compliance with requirements/expectations);
- implementation of directives on liability and safety (governmental decrees etc.) by using

existing harmonized standards (if possible) and other internationally accepted standards.

It is however extremely important to decide at national level which metrology infrastructure is appropriate to fulfill the abovementioned requirements according to national priorities; this involves making decisions for particular physical quantities, their uncertainties, dynamic ranges, traceability paths, financial aspects, trained personnel, accreditation body, sharing of resources, possible intercomparisons, etc.

It is assumed and clearly identified that in the abovementioned activities two areas of activities must be developed in Slovenia:

- **the legal area:** implementation of directives using appropriate guidelines and harmonized technical regulations and standards in the order of priority for Slovenia: for example in the field of legal metrology and prepackaging the directives are: Units of measurement (80/181/EEC), and Nonautomatic weighing instruments (90/383/EEC) as well as current directives that will be replaced by the future "MID" directive.
- **the quality area:** implementation of industrial policy in the field of competitiveness, for example a European Quality Promotion Policy for Improving European Competitiveness.

For both areas, it is evident that the required metrological infrastructure (in terms of finance and expertise) is one of the crucial factors of the implementation of internationally accepted Recommendations and other agreements, either on a voluntary or legally binding basis.

Due to the complexity of the work involved it is planned that in all cases, institutional cooperation or "triangles" as illustrated in Fig. 2 will be formed - this is also considered as being one of the most difficult organizational tasks to accomplish. An institutional triangle typically consists of:

- industrial sector/supplier or provider of services;
- relevant ministries responsible for legal requirements (implementation of directives and/or quality guidelines);
- notified bodies, performing laboratories or other expert institutions.

Legal metrology in Slovenia is the part of the Slovenian metrology infrastructure which has the longest-standing tradition, thus forming a suitable basis for industrial or quality-related measurement tasks; due to the modern trends of deregulation there has also been a significant transition from legal to industrial metrology. The entire scope of legal metrology, with its specifics and tendency to adopt certain internationally agreed common procedures such as the OIML Certificate System or quality systems in legal metrology laboratories should be elaborated separately.

4 International cooperation

It has been considered from the initial stage of the establishment of the Slovenian metrology infrastructure that close collaboration with international metrological institutions was of paramount importance.

Therefore from the outset close connections were established with metrological institutes such as the Netherlands Measurement Institute (NMI) in Delft, the Netherlands, the Physikalisch Technische Bundesanstalt (PTB) in Braunschweig, Germany, the National Institute of Standards and Technology (NIST) in the USA and several others regarding traceability, accreditation, expertise - and especially those having experienced a distributed system of national standards such as Finland, France and Denmark.

From the legislative point of view, the OIML proved to be of great importance, while participation in the International Measurement Konfederation (IMEKO) had a great impact on establishing international cooperation at the initial stage and in metrology research. From the newly obtained status of EUROMET Full Member, Slovenian metrology will benefit further in terms of intercomparisons and mutual metrological research projects. After having established accredited calibration laboratories, as holders of national standards for five basic SI units (kg, m, A, s, and K), the next step should be to join the Meter Convention. ■

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METROLOGICAL INFRASTRUCTURES

Legal metrology in the Republic of Korea

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Abstract

The 33rd CIML Meeting and 5th APLMF Meeting will be held in Seoul, Republic of Korea, from 25 to 30 October 1998. The Editors of the OIML Bulletin therefore felt it would be appropriate to provide Delegates - and other readers - with an overview of metrological activities in Korea.

1 Introduction

Korea's impressive economic strides over the last thirty years have made it the eleventh largest player in the world economy. In the process of such a rapid expansion in the economy, legal metrology and calibration services have been crucial, providing both a technical infrastructure for product quality and the basis for mutual confidence in commercial transactions.

These functions have been part of the main responsibilities of the Korean National Institute of Technology and Quality (KNITQ); this article provides brief but accurate information on the current situation of the legal metrology system in this country, as well as the KNITQ's activities.

2 Brief history

As a nation with a long-standing heritage, Korea has a tradition of metrology which is almost as old as its history. An astronomical observatory (built in 647) and other scientific instruments invented in the 6th and 7th centuries AD indicate that a well-established metrological system already existed even before that time. Indeed, unification of weights and measures was one of the first official decrees passed by the very first king of new dynasties in Korea.

However, the metrological system was to go through revolutionary changes when Korea began to follow western technologies in the latter half of the 19th century: from this time on, the system began to shift from traditional units to international ones. It was in 1883 that the Korean government established its first western-style analytical laboratory, which eventually became the KNITQ (after many name changes).

Even in the early days of changes in the 19th century, Korea realized the importance of international co-operation. In 1894, the Korean government acquired a copy of the standard meter bar (number 10) and a copy of the kilogram mass (number 39) from the BIPM; to

General view of the premises

this day only 38 countries possess a similar set. While the current standard for length no longer relies on using the meter bar, it is still owned by the KNITQ and is regarded as a symbol of authority in metrological control. The kilogram mass is now maintained by the Korean Research Institute of Standards and Science (KRISS), which was established in 1975 as a national measurement laboratory.

3 Authorities in metrological control

The principal legislation in the Republic of Korea concerning legal metrology is the 1961 Weights and Measures Act. Recently revised in 1992 (effective 1993), the Act covers broad areas such as specification of legal units for measuring physical quantities, the national calibration system, and provisions for establishing a national accreditation system for testing/inspection laboratories. The Ministry of Commerce, Industry and Energy maintains this Act, and is also responsible for establishing related policies. However, main responsibilities for administering metrological policies are entrusted to the KNITQ. Under the Weights and Measures Act, the KNITQ manages the legal metrology system in Korea, and coordinates the national calibration system for measuring instruments. KNITQ is also the national standardization body for industrial standards (KS standards), and represents Korea as the national member body in ISO and in the IEC.

Custody of national measurement standards is entrusted to the KRISS which establishes, maintains and disseminates them, while providing education and training in this domain. As a research organization, KRISS is also active in research and development in the fields of measurement science and precision technology.

4 Overview of the legal metrology system in Korea

4.1 Legal units of measurement

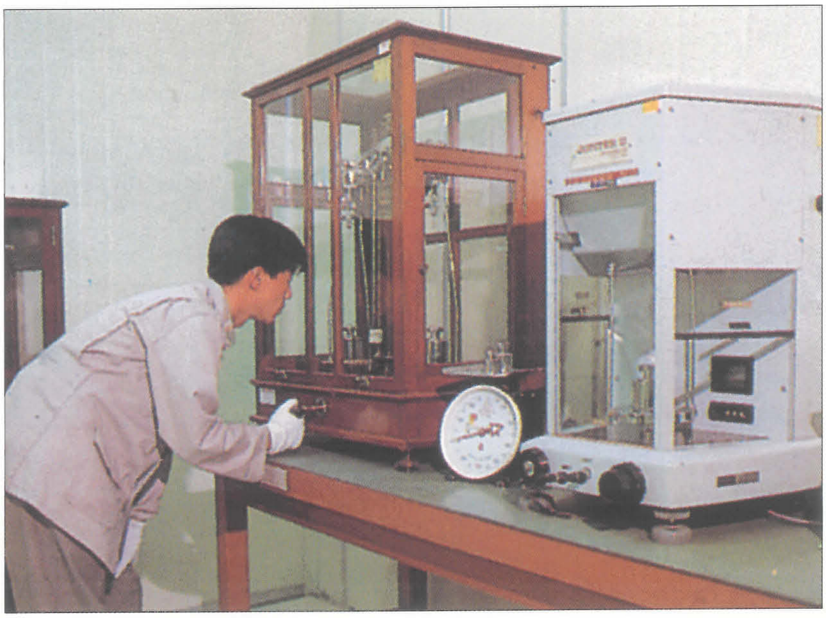
The legal units of measurement in Korea are defined by the Presidential Decree of the Weights and Measures Act. The units are basically the same as those defined in the International System of Units (SI). Unification of all measuring units into the metric system began in 1964, but the units for land measurement and for the construction industry were exempted. Adoption of SI units in the true sense was postponed until January 1, 1983, but this time only a few exceptions were allowed in the following limited sectors: measurements for export-only products, measurements for the maritime/aerospace/defense industries, and measurements for certain scientific research, etc.

4.2 Operation of the National Calibration System

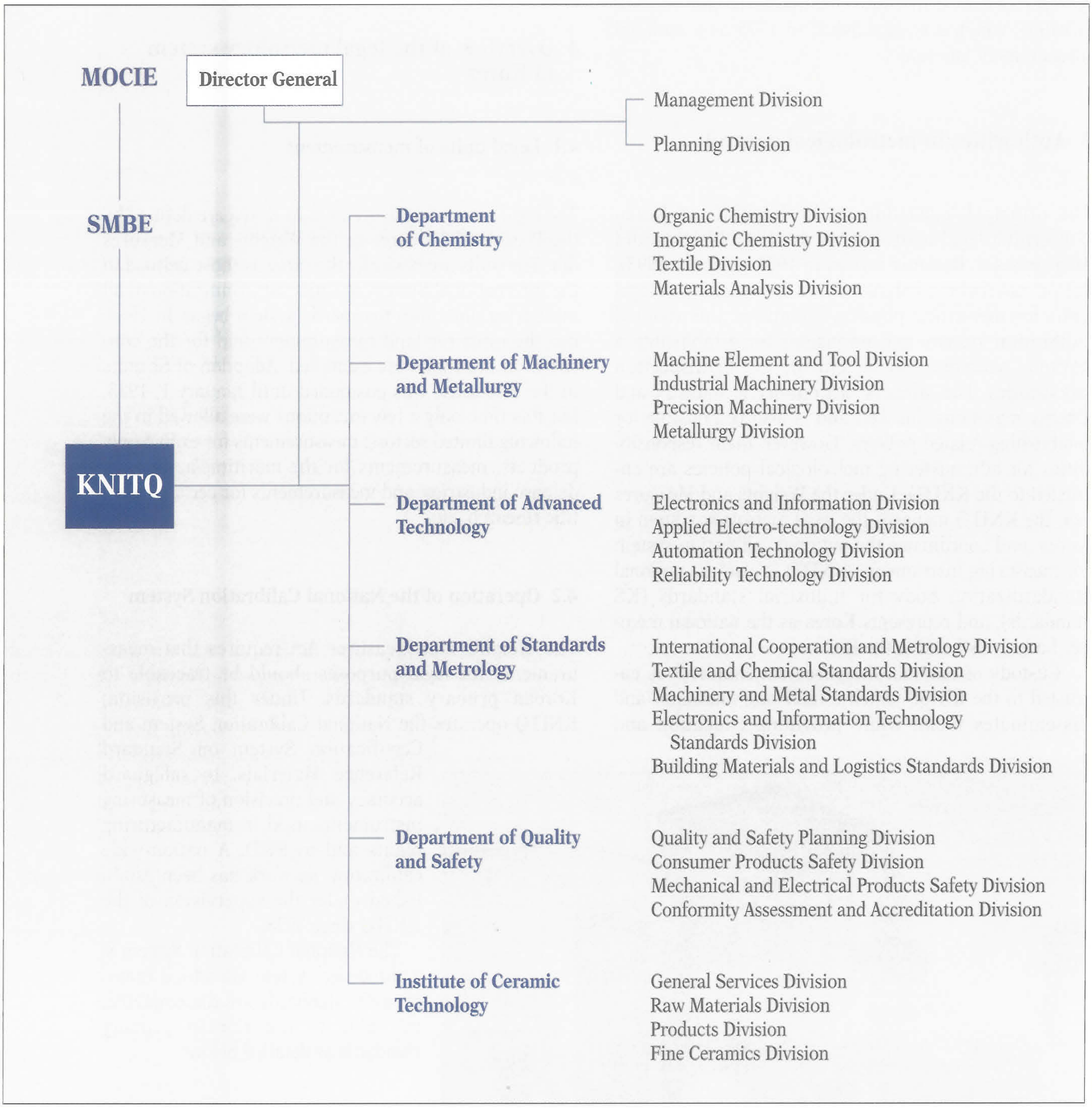
The Weights and Measures Act requires that measurements for legal purposes should be traceable to Korean primary standards. Under this provision, KNITQ operates the National Calibration System and Certification System on Standard Reference Materials, to safeguard accuracy and precision of measuring instruments used in manufacturing plants and in R&D. A nation-wide calibration network has been established under the supervision of the KNITQ since 1978.

The National Calibration System is a three-tier system via which measurement standards are disseminated, traceable to the Korean primary standards as detailed below:

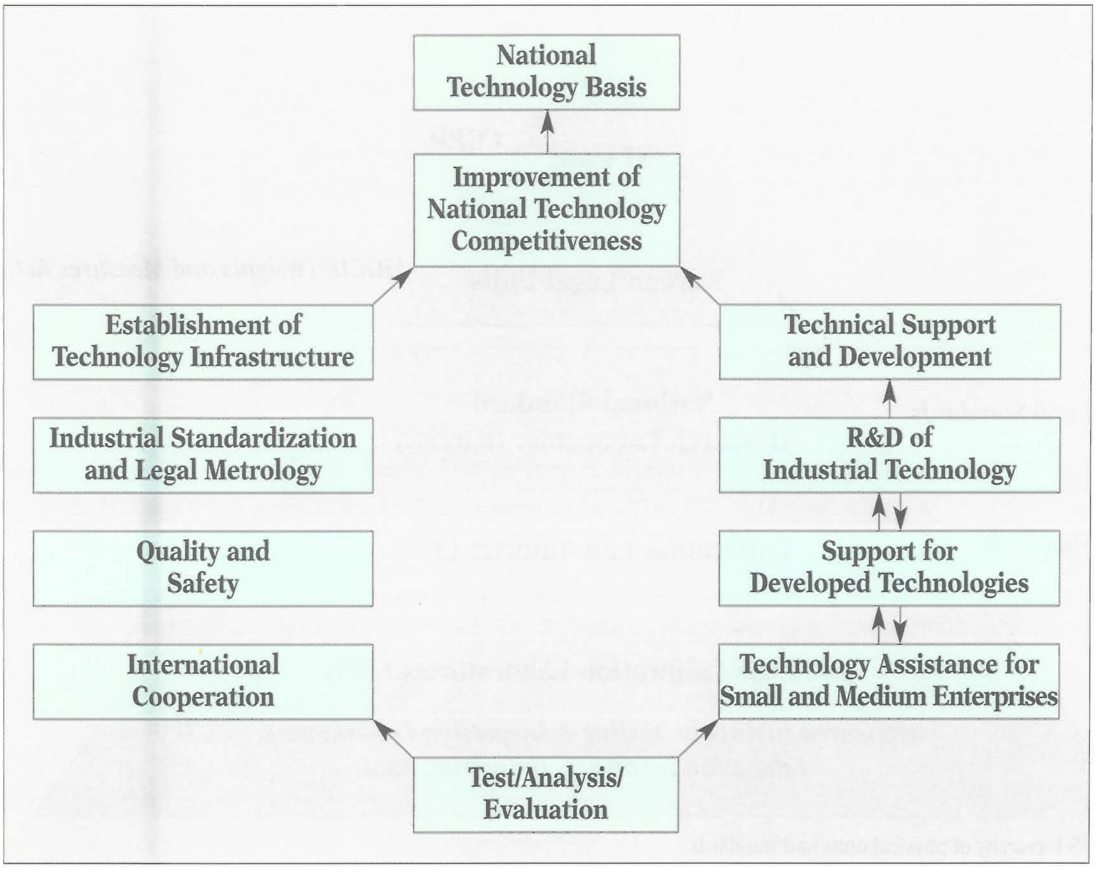
First level: KRISS is the "Primary Calibration Laboratory", the national standards laboratory (unique, as at 1997). It maintains the national measurement standards and disseminates them to lower level calibration laboratories; it is primarily concerned



Mass calibration equipment



Structure of the KNITQ



KNITQ's mission

with measurements of a scientific or purely technical nature. KRISS also provides direct measurement services to industry in fields where industries' calibration laboratories do not have these capabilities;

Second level: KNITQ designates "National Calibration Laboratories" (149 as at 1997), which disseminate the measurement standards to industry; the National Calibration Laboratories provide calibration services and issue calibration certificates to organizations;

Third level: "In-house Calibration Laboratories" (339 as at 1997) are appointed, though - as the name implies - they can only issue calibration reports for their own instruments and disseminate the standards to their own measurement standards.

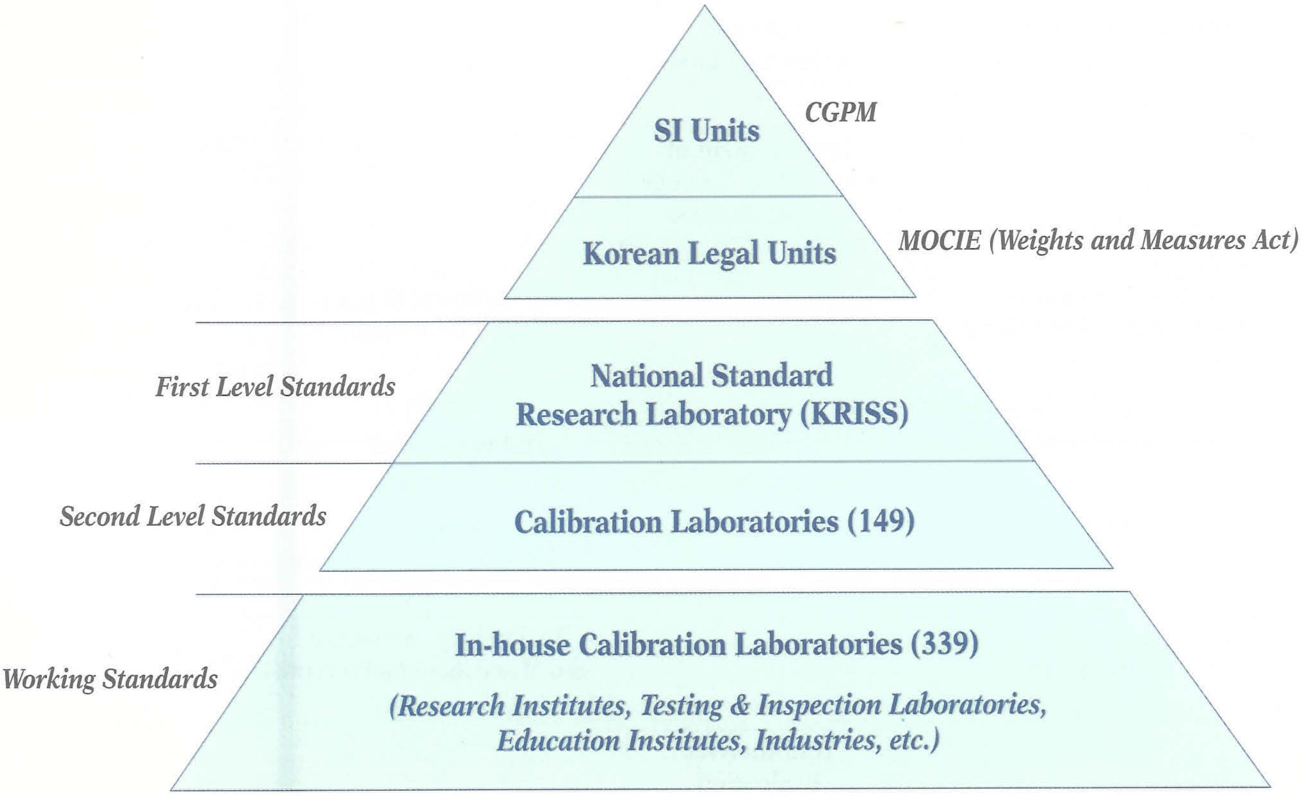
Since the legal requirements vary depending on the required accuracy, a hierarchy of standards has been developed which enables a range of accuracies to be disseminated throughout the country.

4.3 Control of measuring instruments

The Weights and Measures Act divides measuring instruments into two categories. The first category includes those used for trade or certification purposes, in which 134 types are designated by the Presidential Decree. The second category covers all other measuring instruments; manufacturers of all measuring instruments are required to register at the relevant local government authority. Some of the above-mentioned 134 types of measuring instruments are subject to prescribed conformity assessment procedures such as type approval testing and verification.

4.3.1 Type approval (or pattern approval)

The Weights and Measures Act has a provision for type approval testing, and KNITQ is the authority responsible for issuing type approval certificates of measuring instruments for use in commercial transactions or for certification purposes, as prescribed by the Ordinance of the MOCIE (hereafter referred to as The Ordinance of the Ministry). Only those measuring instruments which require verification are covered by type approval testing. Type approval requirements are contained in the verification specifications by order of the KNITQ's Director.



Korea's hierarchy of physical units and standards

After application for type approval is submitted, KNITQ examines the design of measuring instruments and tests samples. Once the type of an instrument is approved, KNITQ issues a certificate of approval, and subsequent instruments manufactured to this type are marked with a KNITQ certification number, which is the same as the one printed on the certificate. The fact that this number is marked on an instrument is the primary indication that it belongs to the approved types.

The principal testing facilities operated by the KNITQ are as follows:

- Mass testing;
- Thermometer testing;
- Volume testing;
- Pressure testing;
- Calorie testing; and
- Electricity testing.

4.3.2 Verification

The Minister of the MOCIE has verification authority for the measuring instruments prescribed by the Presidential Decree in accordance with The Weights and Measures Act. Currently, 18 measuring instruments which are mainly used for commercial transactions are subject to verification. These instruments include taxi meters, weighing scales, watt-hour meters, gas meters, water meters, oil meters, heat meters, medical thermometers, blood pressure meters, etc. Technical specifications for verification of the above instruments are prescribed by the KNITQ Director. The specifications are developed in Metrology Committees which are organized by the KNITQ, and involve technical experts from academic fields, research institutes and industry.

KNITQ may also designate specialized institutes to perform verifications on its behalf; currently there are 13 such designated verification institutes.

The measuring instruments which require verification are as follows:

- Weighing instruments (4 items);
- Weights (2 items);
- Clinical thermometers;
- Watt-hour meters;
- Gas meters;
- Water meters;
- Heat meters;

- Oil meters;
- Liquefied petroleum gas meters;
- Integrating graduated tanks;
- Graduated tank lorries;
- Blood pressure gauges; and
- Fuel oil dispensers.

The requirements for verification are:

- the instruments shall satisfy the type requirements, e.g. structural test, performance test, functional test, marking, etc. (these requirements can be exempted in type approval testing); and
- the instruments shall operate within the appropriate limits of error specified in the Order of the KNITQ's Director.

There are two kinds of verification for the abovementioned measuring instruments: verification after manufacturing or importing, and verification after repair or after expiration of the validity period. (Verification validity periods of measuring instruments are specified by the Ordinance of the Ministry). For verification after manufacturing or importing, the following two institutes besides KNITQ are designated as specialized verification institutes:

- Korea Machinery Meter and Petrochemical Testing & Research Institute (MPI);
- KRISS (but only for verification of normal watt-hour meters).

The authority for verification after repair or after expiration of the validity period has been delegated to the heads of the 15 local governments.

4.3.3 Inspection

Inspection can be carried out in two ways: "periodical" or "irregular". Periodical inspection can be considered as being a simplified version of re-verification, and is conducted annually. Instruments subject to periodical inspection consist of 8 types such as nonautomatic weighing instruments, graduated tanks, etc. The maximum permissible error for periodical inspection is basically 1.5 and 2 times as large as that for verification. But in the case of blood pressure gauges and clinical thermometers, permissible errors are the same as for verification.

5 International cooperation

As described earlier, the Korean government has realized the importance of international cooperation from its early days of industrialization. This tradition was passed on to KNITQ, which puts great emphasis on promoting international collaboration. KNITQ's position is well suited to this commitment, as it is not only the legal metrology authority in Korea, but also the national member body for international organizations such as ISO, IEC and ILAC, and regional organizations such as PASC and APLAC. KNITQ also functions as an official inquiry point for industrial products under the WTO/TBT Agreement.

In the field of legal metrology, Korea joined the OIML in 1978, and has participated in every OIML meeting since 1980. In technical development activities, KNITQ has P-membership in all the 18 OIML TCs, and 15 P-memberships in OIML SCs. KNITQ also actively participates in intercomparison tests which are organized by the APLMF, and currently conducts tests for nonautomatic weighing scales and load cells. KNITQ also maintains formal collaborative relationships with some legal metrology organizations in foreign countries, and hopes to expand these to other countries as well.

6 Conclusions

Legal metrology in Korea has experienced many changes since its commencement almost two millennia ago, but its main objectives have not changed: to safeguard mutual trust in commercial transactions, and to guarantee the accuracy of instruments. With the advance of the global economy, a new mission has been added, which is the promotion of international trade by eliminating technical barriers to trade. As a national organization whose mission is to support industry with a technical infrastructure such as standardization and legal metrology, KNITQ will continue its commitment to these goals and continue its efforts to build a better environment for global trade. ■

liaison activities
OIML
activités de liaison

CECIP

European Committee of Weighing Instrument Manufacturers

48th General Assembly
Prague, Czech Republic
22 May 1998

CECIP held its 48th General Assembly in Prague, Czech Republic at the invitation of the Czech Federation, *Unie vyrobcu vah Ceské republiky*.

During this key meeting of weighing industry members the thirteen member Federations (the Slovak Republic recently having joined) met to evaluate the past year's activities and prepare the future strategy. These Federations represent the following countries:

Belgium - Czech Republic - Finland - France - Germany - Hungary - Italy - Spain -Netherlands - Poland - Slovak Republic - Switzerland - United Kingdom.

This meeting has been an annual event since 29 May 1959, the date on which CECIP was formed with five member Federations (Belgium, France, Germany, Italy, Netherlands), following the 1957 Treaty of Rome.

CECIP's objectives

- to promote high quality technology in the manufacturing of weighing instruments;
- to cooperate with metrology services to establish regulations compatible with this technology;
- to limit regulations and procedures to the minimum necessary to protect consumers' interests;
- to encourage harmonization of regulations to eliminate barriers to trade;
- to ensure that national and international regulations do not hinder the development of new technologies;
- to remain in liaison with national and international organizations and users concerning all aspects of legal metrology, including the harmonized interpretation of regulations;
- to promote broad understanding of modern weighing technology, in particular in developing countries;
- to encourage fair trade practices on the part of all weighing instrument manufacturers throughout the world.

CECIP's organizational structure is illustrated in the Figure (see page 37), including:

- an annual General Assembly which defines CECIP's policy;
- a Bureau which manages and applies the defined policy;
- two working groups: legal metrology and business/trade;
- a Promotion and Communications Committee.

The General Assembly is also an opportunity to invite experts and key individuals from international or European bodies to report on their policies and to share their views on weighing related subjects. This year the Assembly was honored to welcome:

- Mr. Vaclav Kupka, Vice Minister at the Czech Ministry of Industry and Trade, who delivered a speech on how the Czech Economy is closening ties with the European Union;
- Dr. Pavel Klenovsky, Director of the Czech Institute of Metrology, who gave a presentation on mass metrology and the legal aspects thereof in the Czech Republic;
- Prof. Dr. Manfred Kochsiek, Vice-President of the Physikalisch-Technische Bundesanstalt in Germany, who gave a presentation on *An efficient metrological infrastructure - Benefit for industry and society* (published in the OIML Bulletin, April 1998);
- Mr. Denis Redonnet of the European Commission, DG II, Economic and Financial Affairs, who spoke about the main steps in changing over to the Euro and its implications for weighing instruments.

Such high quality interventions are invariably much appreciated by delegates.

Each Federation then presented the situation of the weighing industry in its country, including a combined table summarizing weighing instrument production in Europe.

In addition, the regular agenda items were particularly numerous this year, including:

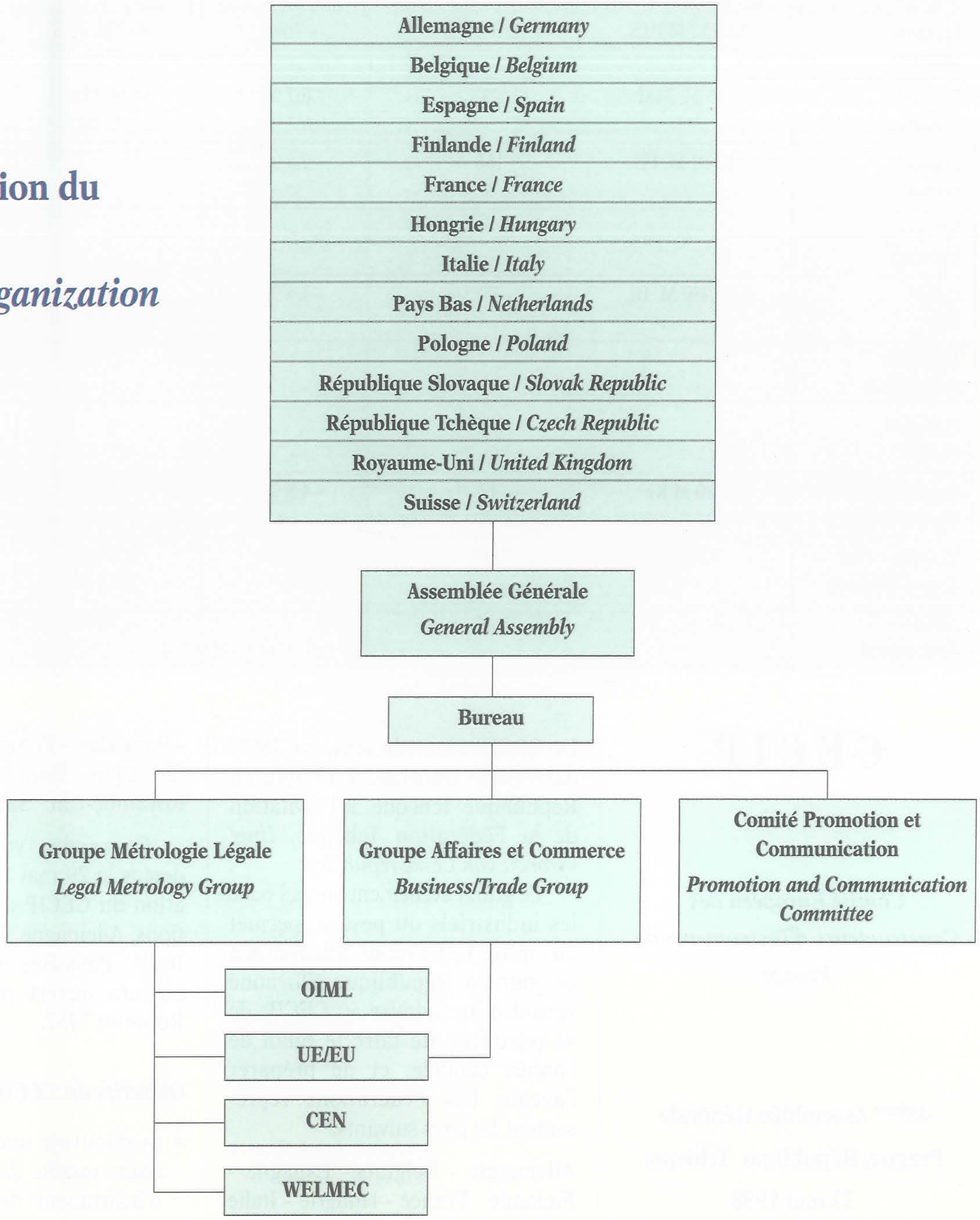
- activity reports by each working group;
- election of a new Vice-President, Mr. Fabio Martignoni;
- admission of a new Federation, the Slovak Republic;
- change of address of CECIP (see below);
- French representation will from now on be handled by COFIP, the French Committee of Weighing Instrument Manufacturers;
- the introduction of a CECIP Internet site:

http://www.CECIP.de

Despite a heavy work program, thanks to the perfect organization of CECIP's Czech hosts (including a gala dinner in the surroundings of a superb monastery) the meeting was a complete success.

Organisation du CECIP

CECIP Organization



Statistiques / *Statistics*
Industrie du Pesage / *Weighing Industry*
• 1997 •

PAYS / *COUNTRY*	PRODUCTION Hors taxe / Ex tax Monnaie locale / Local currency	Hors taxe / Ex tax Million ECU	VARIATION /1996	EXPORT Variation/1996	IMPORT Variation/1996
Allemagne/ *Germany*	1 324 M. DM	671	+ 16 %	687 M. DM + 13,9 %	346 M. DM + 18,9 %
Belgique/ *Belgium*					
Espagne/ *Spain*	16 753 M.PTS	100	+ 7 %	5 407 M. PTS + 10 %	4 041 M. PTS – 6 %
Finlande/ *Finland*	135 M. FIM	22	+ 0,7 %	34 M. FIM – 15 %	65 M. FIM + 3 %
France/ *France*	1 110 M. FF	168	+ 2,4 %		
Hongrie/ *Hungary*					
Italie/ *Italy*	154 030 M. ItL	79	– 4,4 %	35 000 M. ItL + 1,5 %	37 140 M. ItL – 0,5 %
Pays-Bas/ *Netherlands*					
Pologne/ *Poland*					
Rep. Tchèque/ *Czech republic*	380 M.Kc	12	– 4,8 %	28 M.Kc	123,5 M.Kc
Royaume-Uni/ *United Kingdom*	120 M.£	176	– 5 %	98,6 M.£ – 3,3 %	77,2 M.£ + 6,6 %
Suisse/ *Switzerland*				+ 4,4%	+ 2,6 %

CECIP

Comité Européen des Constructeurs d'Instruments de Pesage

48ème Assemblée Générale
Prague, République Tchèque
22 mai 1998

Le CECIP vient de tenir sa 48ème Assemblée Générale à Prague en République Tchèque, à l'invitation de la Fédération Tchèque, *Unie vyrobcu vah Ceské republiky*.

Ce grand événement annuel pour les industriels du pesage, permet aux treize Fédérations adhérentes à ce jour, la République Slovaque venant d'être admise au CECIP, de se retrouver, de faire le bilan de l'année écoulée, et de préparer l'avenir. Ces Fédérations représentent les pays suivants:

Allemagne - Belgique- Espagne - Finlande - France - Hongrie - Italie - Pays Bas - Pologne - République Slovaque - République Tchèque - Royaume-Uni - Suisse.

Ce rendez vous se perpétue depuis le 29 mai 1959, date de création du CECIP avec cinq Fédérations: Allemagne, Belgique, France, Italie, Pays-Bas, qui suivaient le chemin ouvert par le Traité de Rome en 1957.

Objectifs du CECIP:

- promouvoir une technologie de haute qualité dans la fabrication d'instruments de pesage;

- coopérer avec les services de métrologie pour établir les réglementations compatibles avec cette technologie;
- limiter les réglementations et les procédures au minimum nécessaire pour protéger les intérêts du consommateur;
- encourager l'harmonisation des réglementations pour éliminer les entraves aux échanges;
- s'assurer que les réglementations nationales et internationales ne bloquent pas le développement de nouvelles technologies;
- être en liaison avec les organisations nationales et internationales et les utilisateurs concernant tous les aspects de la métrologie légale, y compris l'interprétation harmonisée des réglementations;
- promouvoir une large compréhension des techniques modernes de pesage, en particulier dans les pays en voie de développement;
- encourager des pratiques commerciales courtoises de tous les constructeurs d'instruments de pesage à travers le monde.

Le CECIP est organisé suivant le schéma reproduit dans cet article et comprend:

- une Assemblée Générale annuelle qui définit la politique du CECIP;
- un Bureau qui administre et applique la politique définie;
- deux groupes de travail: métrologie légale/affaires et commerce;
- un Comité de Promotion et de Communication.

L'Assemblée Générale est aussi l'occasion d'inviter des experts ou des personnalités d'organismes internationaux ou européens qui font part de leur politique ou de leur point de vue sur des sujets touchant le pesage. Cette année l'Assemblée a eu l'honneur de recevoir:

- M. Vaclav Kupka, Vice-Ministre au Ministère de l'Industrie et du Commerce Tchèque, avec un discours sur l'Economie Tchèque sur le chemin de l'Union Européenne;
- Dr. Pavel Klenovsky, Directeur de l'Institut de Métrologie Tchèque qui a présenté la métrologie des masses en République Tchèque et ses aspects légaux;
- Prof. Dr. Manfred Kochsiek, Vice-Président du Physikalisch-Technische Bundesanstalt en Allemagne, avec sa présentation *"Une infrastructure métrologique efficace - Avantage pour l'industrie et pour la société"* (article publié dans le Bulletin OIML d'avril 1998);
- M. Denis Redonnet, de la Commission Européenne, DG II, Affaires Economiques et Financières, qui a parlé de l'Euro, principales étapes et incidence sur les instruments de pesage.

Toutes ces interventions de grande qualité sont toujours très appréciées par l'ensemble des délégués.

Chaque Fédération a ensuite présenté la situation de l'industrie du pesage dans son pays, avec un tableau récapitulatif (joint à cet article) de la production d'instruments de pesage en Europe.

De plus, la partie statutaire était très dense cette année avec:

- les rapports d'activité de chaque groupe de travail;
- l'élection d'un nouveau Vice-Président, M. Fabio Martignoni;
- l'admission d'une nouvelle Fédération, la République Slovaque;
- le changement d'adresse du CECIP (voir ci-après);
- la représentation française désormais assurée par le COFIP, Comité Français des Industriels du Pesage;
- la naissance d'un site CECIP sur Internet:

http://www.CECIP.de

Malgré un programme très chargé au cours de cette Assemblée Générale, grâce à la Fédération Tchèque, qui a assuré une parfaite organisation (et à un dîner de gala dans le cadre d'un superbe monastère) tous les travaux se sont parfaitement déroulés. ■

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France

Tel./Fax: +33 (0) 1 60 02 89 58

Coordination of metrological activities in CIS (Commonwealth of Independent States) countries

V.N. Koreshkov, V.F. Pulyaev, N.A. Kusakin and N.A. Zhagora, Belstandart, Minsk, Belarus

To ensure that activities of the National Metrological Services of CIS countries are effective in the field of measurement standards, state tests, metrological certification, verification and calibration of measuring instruments and accreditation of testing and verification laboratories, the Heads of CIS countries Governments have signed the following Resolutions:

- Agreement on implementation of coordinated policy in the field of standardization, metrology and certification - 13 March 1992, Moscow; this agreement was signed by the Republic of Azerbaijan, the Republic of Armenia, the Republic of Belarus, Georgia, the Republic of Kazakhstan, the Republic of Kyrgystan, the Republic of Moldova, the Russian Federation, the Republic of Tadjikistan, Turkmenistan, the Republic of Uzbekistan and Ukraine.
- Agreement on cooperation for ensuring the uniformity of time and frequency measurements - 9 October, 1992 Bishcek;
- Agreement on immunity from custom duties, taxation and on giving special license for the transit of normative documents, measurement standards and reference materials, for the purposes of verification and metrological certification - 10 February 1995, Alma-Ata.

To settle matters in an efficient way the Heads of Governments have established an Interstate Council for Standardization, Metrology and Certification (ISC), of which the Heads of National Bodies for Metrology became members. This Council accepted Agreements on:

- Mutual recognition of state tests, type approval, metrological certification, verification and calibration of measuring instruments, results of laboratory accreditation that perform tests, verification and calibration of measuring instruments - 6 October 1992, Tashkent;
- Cooperation for production and application of reference materials for composition and properties of substances and materials - 6 October 1992, Tashkent;
- Cooperation for production and use of data on physical constants and properties of substances and materials - 6 October 1992, Tashkent.

For the purposes of the Agreement implementation, five programs for joint activity were approved:

1. Program for the transfer of the physical unit from reference measurement standards and intercomparisons of state (national) and working measurement standards;
2. Program for development and revision of normative documents in field of metrology;
3. Program for work in field of non-destructive testing;
4. Program for joint activities on production and application of reference materials for composition and properties of substances and materials;
5. Program for joint CIS countries' work on the realization of an Agreement on cooperation for ensuring the uniformity of time and frequency measurements.

Problems of project realization are considered twice a year during meetings of the Provisional Scientific Technical Commissions (PSTC) for Metrology and the corresponding Provisional Working Groups (PWG) for Time and Frequency / Reference Materials / Non-destructive testing.

After drafts of the normative documents and appropriate drafts of the procedures and rules have been discussed at the PSTC and PWG, they are submitted for approval at the ICS meeting.

Within the framework of the *"Program for joint activities on production and application of reference materials for composition and properties of substances and materials"* the following normative documents were developed and approved:

- RIS 16-96 *"Regulations for Interstate Reference Material"*
- RIS 17-96 *"Procedure for planning the activities for cooperation in field of Reference Materials for composition and properties of substances and materials."*

More than 120 types of reference materials were approved as Interstate Reference Materials in 1997.

In accordance with the *"Program of work in the field of Non-destructive testing"* the following were developed and approved:

"Requirements for competence of Non-destructive testing and technical diagnostics laboratories";

GOST (EN 473) - *"Qualification and certification of Non-destructive testing personnel"*;

GOST (EN 45013) - *"General criteria for certification bodies operating certification of personnel"*; *"Recommendations for developing the Quality Manual of Non-destructive testing laboratories"*;

"Manufacture sectors. Definitions for certification of Non-destructive testing personnel".

National bodies for metrology included in the *"Program of activities for transfer of unit from reference standards and collaboration in the field of measurement standards"*:

- 103 reference (measurement) standards from the Republic of Azerbaijan,
- 58 from the Republic of Armenia,
- 59 from the Republic of Belarus,
- 25 from the Republic of Georgia,
- 115 from the Republic of Kazakhstan,
- 78 from the Republic of Kyrgystan,
- 150 from the Republic of Moldova, and
- 131 from the Republic of Uzbekistan respectively.

Drafts of metrological regulations for procedures of measurement standards intercomparisons and calibration intervals determination, and of an Agreement on *"Cooperation for establishing Interstate Measurement Standards"* and *"Regulation for Interstate Measurement Standards"* are currently being developed.

14 new editions of Standards of the System for ensuring the uniformity of measurements replacing previously approved Standards and 6 drafts for the processing of measurement results, metrological examination of documents and certification of measuring instruments, etc. will be developed within the framework of the *"Program for developing and revising metrological normative documents"*.

National bodies for metrology have prepared an Interstate Model Law on ensuring the uniformity of measurements and a Memorandum on the establishment of a European-Asian Regional Organization for laboratory accreditation. ■

8th COOMET Committee Meeting

Minsk, 12–13 May 1998

Account by Prof. Dr. M. Kochsiek

The 1998 meeting of the COOMET Committee (Cooperation in Metrology of the countries of Central and Eastern Europe and of the Community of Independent States (CIS)) was held from 12–13 May 1998 in Minsk on the invitation of the ZESM (Centre of Standardization and Metrology).

40 representatives of the metrological state institutes of the member countries, i.e. Belarus, Bulgaria, Germany, Lithuania, Moldavia, Poland, Russia, Slovakia and the Ukraine took part in the meeting. The International Bureau of Weights and Measures (BIPM) was represented by its Director, Mr. T. Quinn. The Intergovernmental Council of Standardization, Metrology and Certification (MGS-SMS) of the Community of Independent States also sent an observer.

The meeting, which was opened by the Minister of Trade of the Republic of Belarus, focused on the following topics:

- Mr. Quinn's report on the 2nd meeting of the Directors of the national metrology institutes and the establishment of the Joint Committee of the regional metrology organizations and of the BIPM in February 1998 in Paris;
- the report of the Secretariat and the reports of the rapporteurs;
- Mr. M. Kochsiek's report on the current activities of the OIML, particularly on the development of the OIML Certificate System;
- the election of a new COOMET chairman: Mr. V. Belozerkovski (Moscow) of the Gosstandart of Russia (decisive reasons: as a member of the Metre Convention and of the OIML, Russia is represented in important metrological organizations and has a highly developed metrology system);
- the confirmation of new Committee members: Mr. Ivan Temniskov for Bulgaria, Mr. H.-D. Velfe for Germany replacing the former representative of the PTB, Prof. Dr. M. Kochsiek;
- the nomination of new rapporteurs: Mr. H. Durlik (GUM, Warsaw) for the *"Mass, force, pressure"* field replacing Mr. B. Piotrowska, and Mr. A. Leonow (VNIIMS, Moscow) replacing Mr. J. Lipinski for the *"Reference materials"* field.

Mr. Quinn emphasized the importance of regional metrology organizations for the acceptance of the equivalence of standards and comparison measurements throughout the world, in particular for the performance of *key comparisons*; he referred to the draft agreement between the national metrology institutes on mutual acceptance of their national standards and calibration certificates. A list containing 60 topics for *key comparisons* will be submitted to the COOMET Secretariat.

In the report of the Secretariat a further reduction of the protracted and partly not even finalized projects, which was agreed upon by the contact persons at their meetings, was recommended and highly welcomed. It was suggested not to extend the duration of the projects beyond two years. At present:

- 26 approved projects are being dealt with (as against 33 last year);
- 25 projects are at approval stage;
- 22 projects were finalized or deleted;
- 8 new projects were adopted.

Mr. H. Apel submitted two proposals of new projects in the *"General metrology, legal metrology and calibration services"* field. The participants showed their interest, but however did not finally approve these at the meeting; a special working committee will be dealing with this subject.

The Committee thanked its chairman, Mr. R. Spurny (SMU, Bratislava), who left the Committee after four years in office for the work he had carried out and for that of the Secretariat, and also Mr. Kochsiek who is a co-founder of COOMET and who leaves the Committee after seven years of cooperation.

The discussions were supplemented by two lectures:

- *"Introduction to the Measurement Standards of the Republic of Belarus"* by Mr. N. Zhagora, ZESM; and
- *"Recent Developments of the European Measuring Instruments Directive MID 2"* by Mr. H. Apel, PTB, and by visits to various laboratories of the ZESM.

Mr. Kochsiek was invited to present a lecture on 14 May following the COOMET meeting on *"The uncertainty of measurement for the user of a calibrated or verified instrument"* to the ZESM staff and to employees of the metrological services of Moldavia, Poland and Ukraine.

The 9th COOMET meeting will take place in Moscow on the invitation of the Russian Gosstandart.

For schedule reasons (preparation of the 33rd CIML meeting) this COOMET meeting is planned to take place in September 1999 instead of next spring. ■

In this Bulletin: OIML certificates registered

Dans ce Bulletin: certificats OIML enregistrés

1998.05 – 1998.07

OIML Certificate System

The OIML *Certificate System for Measuring Instruments* was introduced in 1991 to facilitate administrative procedures and lower costs associated with the international trade of measuring instruments subject to legal requirements.

The System provides the possibility for a manufacturer to obtain an OIML certificate and a test report indicating that a given instrument pattern complies with the requirements of relevant OIML International Recommendations.

Certificates are delivered by OIML Member States that have established one or several Issuing Authorities responsible for processing applications by manufacturers wishing to have their instrument patterns certified.

OIML certificates are accepted by national metrology services on a voluntary basis, and as the climate for mutual confidence and recognition of test results develops between OIML Members, the OIML Certificate System serves to simplify the pattern approval process for manufacturers and metrology authorities by eliminating costly duplication of application and test procedures. ■

Système de Certificats OIML

Le *Système de Certificats OIML pour les Instruments de Mesure* a été introduit en 1991 afin de faciliter les procédures administratives et d'abaisser les coûts liés au commerce international des instruments de mesure soumis aux exigences légales.

Le Système permet à un constructeur d'obtenir un certificat OIML et un rapport d'essai indiquant qu'un modèle d'instrument satisfait aux exigences des Recommandations OIML applicables.

Les certificats sont délivrés par les États Membres de l'OIML, qui ont établi une ou plusieurs autorités de délivrance responsables du traitement des demandes présentées par des constructeurs souhaitant voir certifier leurs modèles d'instruments.

Les services nationaux de métrologie légale peuvent accepter les certificats sur une base volontaire; avec le développement entre Membres OIML d'un climat de confiance mutuelle et de reconnaissance des résultats d'essais, le Système simplifie les processus d'approbation de modèle pour les constructeurs et les autorités métrologiques par l'élimination des répétitions coûteuses dans les procédures de demande et d'essai. ■

This list is classified by Issuing Authority; updated information on these Authorities may be obtained from the BIML.

Cette liste est classée par Autorité de délivrance; les informations à jour relatives à ces Autorités sont disponibles auprès du BIML.

► **Issuing Authority / *Autorité de délivrance***

Physikalisch-Technische Bundesanstalt (PTB), Germany

R 76/1992 - DE - 93.01
Sartorius AG
Weender Landstraße 94-108, D-37075 Göttingen, Germany
BA BA 200, BA BB 200, ...

For each Member State, certificates are numbered in the order of their issue (renumbered annually).

Pour chaque État Membre, les certificats sont numérotés par ordre de délivrance (cette numérotation est annuelle).

OIML Recommendation applicable within the System / Year of publication

Recommandation OIML applicable dans le cadre du Système / Année d'édition

Year of issue

Année de délivrance

The code (ISO) of the Member State in which the certificate was issued.

Le code (ISO) indicatif de l'État Membre ayant délivré le certificat.

Applicant

Demandeur

Certified pattern(s)

Modèle(s) certifié(s)

For up to date information on OIML certificates:

Pour des informations à jour sur les certificats OIML:

http://www.oiml.org

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic catchweighing instruments
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique

R 51 (1996)

► **Issuing Authority** / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R51/1996-NL-98.01
Types HI-3600E (Twin) and WI-3600E (Classes X(1) and Y(a))
Digi Europe Limited, Digi House, Rookwood Way, Haverhill, Suffolk, CB9 8DG, United Kingdom

R51/1996-NL-98.02
AW-2600 SMT (Class Y(a))
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, Tokyo 146, Japan

R51/1996-NL-98.03
AW-2600 SMT (Class Y(a))
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, Tokyo 146, Japan

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Load cells
Cellules de pesée

R 60 (1991), Annex A (1993)

► **Issuing Authority** / *Autorité de délivrance*

Office Fédéral de Métrologie, Switzerland

R60/1991-CH-98.01
Load Cell Type CE 450 (Class C)
Digi-Sens AG, Spitalstrasse 49, 3280 Meyriez / Murten, Switzerland

► **Issuing Authority** / *Autorité de délivrance*

Danish Agency for Development of Trade & Industry, Denmark

R60/1991-DK-97.04 Rev. 1
Compression load cell type SCA (Class C)
Cardinal Scale Manufacturing Co., 203 East Daugherty St., Webb City, Missouri 64870, USA

► **Issuing Authority** / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R60/1991-NL-98.01
W-DLC/01 (Classes C and D)
Welvaarts weegsystemen, De Tweeling 4, 5215 MC's-Hertogenbosch, The Netherlands

R60/1991-NL-98.02
3510, maximum capacity: 300, 450, 500, 750 and 1000 kg (Class C)
Tedea Huntleigh Europe Ltd., 37 Portmanmoor Road, Cardiff CF2 2HB, United Kingdom

R60/1991-NL-98.02 Rev. 1
3510, maximum capacity: 300, 450, 500, 750, 1000 and 1200 kg (Class C)
Tedea Huntleigh Europe Ltd., 37 Portmanmoor Road, Cardiff CF2 2HB, United Kingdom

R60/1991-NL-98.03
ACJ (Class C)
Scaime S.A., Le bois de Juvigny, B.P. 501, 74105 Annemasse, France

R60/1991-NL-98.04
MV (Class C)
Epel Industrial S.A., Ctra. Sta. Cruz de Calafell, 35 km. 9,400, 08830 Sant Boi de Llobregat, Barcelona, Spain

R60/1991-NL-98.05
LC (Class C)
Epel Industrial S.A., Ctra. Sta. Cruz de Calafell, 35 km. 9,400, 08830 Sant Boi de Llobregat, Barcelona, Spain

R60/1991-NL-98.06
SSM (Class C)
Interface, Inc., 7401 E. Butherus Drive, Scottsdale, AZ 85260, USA

R60/1991-NL-98.07
PW12 (Classes C and D)
Hottinger Baldwin Messtechnic Wägetechnik GmbH,
Im Tiefen See 45, D-64293 Darmstadt, Germany

R60/1991-NL-98.08
FB (Class C)
NBC Elettronica Srl., via Bersagilo 20,
I-22015 Gravedona (CO), Italy

R60/1991-NL-98.09
BSA (Class C)
CAS Corporation, # 19 Kanap-ri Kwangjeok-myon,
Yangju-kun Kyungki-do, South Korea

R60/1991-NL-98.10
PW10 (Classes C and D)
Hottinger Baldwin Messtechnic Wägetechnik GmbH,
Im Tiefen See 45, D-64293 Darmstadt, Germany

R60/1991-NL-98.11
SHBxR (Class C)
Revere Transducers Europe BV, Ramshoorn 7,
4824 AG Breda, The Netherlands

R60/1991-NL-98.12
FFX... (Class C)
MASTER-K, 38, Avenue des Frères Montgolfier, B.P. 186,
69686 Chassieu Cedex, France

R60/1991-NL-98.13
SP4 (Class C)
HBM Inc., 19 Bartlett Street, Marlboro, MA 01752, USA

R60/1991-NL-98.14
LC-2 (Class C)
Epel Industrial S.A., Ctra. Sta. Cruz de Calafell, 35 km. 9,400,
08830 Sant Boi de Llobregat, Barcelona, Spain

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic gravimentric filling instruments
Doseuses pondérales à fonctionnement automatique

R 61 (1996)

▶ **Issuing Authority** / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R61/1996-NL-98.01
Types ADW- ..... (Class X(0.5))
Yamato Scale GmbH, Hanns-Martin-Schleyer Straße 13,
D-47877 Willich, Germany

R61/1996-NL-98.02
*Type GR-** (Class X(1))*
Elpack Packaging Systems, Ltd., 37 Haela St. Industrial Zone,
Even Yehuda 40500, Israël

R61/1996-NL-98.03
*Type BOS-**-** (Class X(1))*
Precia-Molen, Teteringsedijk 53, 4817 MA Breda,
The Netherlands

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INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Nonautomatic weighing instruments
Instruments de pesage à fonctionnement non automatique

R 76-1 (1992), R 76-2 (1993)

▶ **Issuing Authority** / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R76/1992-DE-98.02
Nonautomatic electromechanical weighing instrument types DS BH 300, DN BH 300 and DQ BH 300 (Class III)
Sartorius A.G., Weender Landstraße 94-108, D-37075 Göttingen, Germany

▶ **Issuing Authority** / *Autorité de délivrance*

Danish Agency for Development of Trade & Industry, Denmark

R76/1992-DK-96.02
Type WI-120 (Class III)
Salter Weigh-Tronix Ltd., George Street, West Bromwich, West Midlands B70 6AD, United Kingdom

R76/1992-DK-96.03
Type WI-125 or WI-825 (Class III)
Salter Weigh-Tronix Ltd., George Street, West Bromwich, West Midlands B70 6AD, United Kingdom

R76/1992-DK-96.04
Type WI-150 or WI-152 (Class III)
Salter Weigh-Tronix Ltd., George Street, West Bromwich, West Midlands B70 6AD, United Kingdom

R76/1992-DK-96.05
Type WI-130 (Class III)
Salter Weigh-Tronix Ltd., George Street, West Bromwich, West Midlands B70 6AD, United Kingdom

R76/1992-DK-98.01
Type WI-127 (Class III)
Salter Weigh-Tronix Ltd., George Street, West Bromwich, West Midlands B70 6AD, United Kingdom

▶ **Issuing Authority** / *Autorité de délivrance*

Sous-direction de la Métrologie, France

R76/1992-FR-97.03 Rev. 1
Balance électronique TESTUT ALPHA J8 (Classe III)
Société Testut, 957 rue de l'Horlogerie, BP 11, 62401 Béthune, France

▶ **Issuing Authority** / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R76/1992-NL-97.14 Rev. 1
Type MSI-3360 .... (Class III)
Measurement Systems International, Inc., 14240 Interurban Avenue South, Seattle, Washington 98168-4660, USA

R76/1992-NL-98.02
Type SL 9000 (Class III)
Tokyo Electric Co., Ltd., 6-78, Minami-cho, Mishima-shi, Shizuoka-ken 411, Japan

R76/1992-NL-98.03
Type DPS-3600.. (Class III)
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, Tokyo 146, Japan

R76/1992-NL-98.04
Type NGA (Class III)
Epelsa, S.L., C/. Albasanz, 6-8, 28037 Madrid, Spain

R76/1992-NL-98.05
Type SM 90.. (Class III)
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, Tokyo 146, Japan

R76/1992-NL-98.06
Type DC-688.. (Class III)
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, Tokyo 146, Japan

R76/1992-NL-98.07
Type DS-688.. (Class III)
Teraoka Seiko Co., Ltd., 13-12 Kugahara, 5-Chome, Ohta-ku, Tokyo 146, Japan

R76/1992-NL-98.08
Type DigiSet-XC (Class III or IIII)
Jonker Elektrotechnische Bedrijfsautomatisering bv, De Mors 19, 7151 MX Eibergen, The Netherlands

R76/1992-NL-98.09
Type BW (Class III)
CAS Corporation, # 19 Kanap-ri Kwangjeok-myon, Yangju-kun Kyungki-do, South Korea

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic weighing instruments
Instruments de pesage à fonctionnement automatique

R 107 (1997)

- **Issuing Authority** / *Autorité de délivrance*

Sous-direction de la Métrologie, France

R107/1997-FR-98.01
BASIA 3 BC (Classes 0,2; 0,5; 1 et 2)
Pesage Lorrain Continu et Discontinu (P.L.C.D.), 86, rue Jean Burger, 57070 Saint Julien Lès Metz, France

- **Issuing Authority** / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R107/1997-NL-98.01
Type ABS-..-.. (SCS, if applicable) (Class 0.2)
Precia-Molen, Teteringsedijk 53, 4817 MA Breda, The Netherlands

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Fuel dispensers for motor vehicles
Distributeurs de carburant pour véhicules à moteur

R 117 (1995) [+ R 118 (1995)]

- **Issuing Authority** / *Autorité de délivrance*

Netherlands Measurement Institute (NMi) Certin B.V., The Netherlands

R117/1995-NL-98.01
Fuel dispensers for motor vehicles, model Euro Premier (Class 0.5)
Tokheim Europe B.V., Reaal 5C, 2353 TK Leiderdorp, The Netherlands

IMEKO PTB OIML BIPM

INTERNATIONAL SEMINAR
The Role of Metrology in Economic and Social Development
Braunschweig, Germany 16–19 June 1998

Over 220 Delegates from some eighty countries and seventeen international and regional organizations attended the International Seminar on "The Role of Metrology in Economic and Social Development", held in the Braunschweig Stadthalle and organized jointly by the PTB, IMEKO, the BIPM and the OIML.

Braunschweig, the city of Henry the Lion, is a small but attractive town boasting many sites of historical interest and long-standing traditions. The town, which is home to the PTB, is situated about 70 km east of Hannover. Delegates were able to savor the town's atmosphere - all the hotels were within easy walking distance of the quaint pedestrian town center - and were also privileged to be invited to a welcome party and two receptions, one organized by the Lord Mayor in the Altstadtrathaus (Old Town Hall) and the other in the Knight's Hall of the impressive Dankwarderode Castle.

On the following pages we have printed a summary of the key points raised and debated; the Seminar was undeniably a real success thanks to the high quality of the speakers' presentations and lectures and by the sheer number of different subjects raised. There is certainly much food for thought for follow-up meetings, and Delegates left the information-saturated week of activity in the knowledge that metrology is keeping up with the times and evolving throughout the world.

Photo: PTB

Delegates attending the Seminar in Brauschweig, Germany

Proceedings of the Seminar

Photo: BIML

Ernst O. Göbel

The Seminar was officially opened on Tuesday 16 June by Mr. Ernst O. Göbel (President of the Physikalisch-Technische Bundesanstalt). Mr. Göbel briefly presented the PTB, then explained that the main goal of this Seminar was to attempt to harmonize the objectives of international and regional organizations in the field of metrology. He expressed his satisfaction at being able to welcome so many delegates to this major event, including representatives from seventeen international and regional organizations.

Photo: BIML

Eike Röhling

In the name of the Federal Minister for Economics for Germany, participants were then addressed by Mr. Eike Röhling (Head of the Department Strukturpolitik, Forschungs-, Innovations- und Technologiepolitik). Mr. Röhling explained the role of the Federal Ministry in reconstructing the former GDR, whose infrastructure has recently witnessed substantial development. He stressed the importance of the international aspects of metrology and also the significance of accreditation and certification. He wished the Seminar every success, and expressed his understanding of the relevance of such an essential meeting.

Plenary Session 1

Tuesday 16 June 1998

Photo: PTB

Dieter Kind

Mr. Dieter Kind (Past President of the PTB) opened the First Plenary Session by saying that erroneous measurements can destroy confidence and lead to wrong decisions being taken by governments, serious medical errors being made, and other far-reaching consequences.

A coherent structure of metrological activities could also serve to reduce technical barriers to trade, a point developed in some detail by Ms. Vivien Liu (Secretary to the Technical Barriers to Trade (TBT) Committee of the World Trade Organization (WTO)). The WTO deals with rules for international trade with the aim of encouraging free international exchange by minimizing tariff or non-tariff related barriers to trade.

132 governments are members of the Organization, which is also an International Court for settling international disputes via governments representing their national industrial interests. The WTO also assists and encourages developing countries to play an active role in international trade.

The WTO TBT Agreement provides discipline for members to prepare, adopt and apply voluntary standards, mandatory technical regulations and procedures for conformity assessment by central and local government bodies and non-governmental and regional bodies.

The basic TBT principles are:

- non-discrimination;
- no creation of unnecessary obstacles to trade;
- harmonization of the use of international standards;
- equivalence;
- mutual recognition;
- transparency;
- notifications;
- inquiry points concerning standards and regulations, etc.

To conclude, Ms. Vivien Liu said that industry has to sharpen its metrological skills to be competitive and compatible and to successfully reduce fraud. To arrive at a common infrastructure, there is a need for cross-border harmonized standards, which form the basis for economic growth and stability.

There is also a need to help countries in transition towards a market economy to develop their own sound metrological infrastructures so that they may access the global market. The challenge in this field is to improve the global structures at regional, international and national levels.

On the subject of globalization, Mr. Khalil Hamdani (Officer in Charge of the National Innovation and Investment Policy Branch of the United Nations Conference on Trade and Development, UNCTAD) stated that a key indication for globalization is direct foreign investment.

Developing countries now invest as much as the "developed" countries did in the 1980's. Exports usually follow foreign investment, and trade and technology transfers also follow suit. We now witness deep rather than shallow integration of cross-border trade. In the past, foreign investment activities were limited to buyer-seller transactions; now, significant economies of scale are achieved by combining companies in different countries.

Evoking the negative points of globalization, Mr. Hamdani stated that globalization presents risks to smaller nations because corporate research and development strategies do not favor small and medium companies (SME's). The new emphasis should be on making use of technology rather than just acquiring it.

Following on from Mr. Hamdani's presentation, Mr. Wolf Preuss (Head of Department, Federal Ministry of Economic Cooperation and Development, BMZ, Germany) considered that metrology is an essential tool to protect the standard of living, for example by regulating environmental policy and systems and improving human development. Metrology has a political role to play in respecting human rights, market/social oriented policies, rules of law, etc.

In the Round Table discussion which concluded the First Plenary Session, interesting points were raised such as:

- the suggestion that the SI system of units be used internationally to limit TBT's;
- the concern voiced by many participants that metrology was not granted sufficient funding by their governments or outside sources. The WTO responded that developing countries should raise such questions and concerns as a group rather than individually when requesting assistance;
- the OIML is now an observer member of WTO TBT meetings and so is now increasingly involved in these activities; the OIML could help in seeking assistance from the WTO or other such organizations;
- increased ongoing collaboration between international bodies is essential, however there is also a need for more involvement and more contacts amongst national scientific experts;
- a proposal was made to develop a "white paper" which would be used to present the importance and the role of metrology to individual governments to raise awareness on metrology issues, and to secure the necessary funding;
- the question was raised as to whether the future of metrology is in the hands of governments or in the hands of industry;
- there is still much to be done to render the importance of the role of metrology more visible, and to close the gap between the economy and metrology.

Plenary Session 2

Tuesday, 16 June 1998

Mr. Jean Kovalevsky (President of the Comité International des Poids et Mesures, CIPM) opened the Second Plenary Session by speaking about one of the recent key developments in metrology, i.e. metrology in chemistry - in fact a small chemistry section will be created at the BIPM.

The BIPM will also become involved in hardness, flow, acoustic and vibration measurements, as well as in environmental and health issues.

In order to achieve worldwide traceability of standards the CIPM has set up a two-level system of comparisons:

- "key comparisons" organized by the relevant Consultative Committees (CC);
- regional comparisons based on the results of key comparisons.

The BIPM prepared a document on mutual recognition of the equivalence of national measurement standards and calibration certificates issued by NMI's, the signature of which is envisaged for 1999.

The CIPM is preparing a report for governments (which is almost completed) on "International cooperation relating to metrology and the role of the BIPM".

Mr. Kovalevsky also commented that the VIM and the GUM will be revised in the near future by the recently created Joint Committee on Guides in Metrology (JCGM), and that the BIPM is looking to expand metrology to its broadest sense.

Mr. Gerard Faber (President of the Comité International de Métrologie Légale (CIML)) took the floor and delivered a speech on the OIML and its program, which is printed later in this article.

Mr. Eberhard Seiler (Chairman of IMEKO TC 11 "Metrological infrastructures") presented the general scope and program of the International Measurement Confederation (IMEKO) and then outlined the goals

Photo: PTB

Braunschweig Stadthalle

and programs of TC 11 which are: to collect, discuss and disseminate know-how on the establishment and development of metrological infrastructures in order to help countries to set up such infrastructures. The co-sponsorship/organization of this Seminar is a major contribution of the TC 11 program.

As Chairman of the International Laboratory Accreditation Conference (ILAC), Mr. John Gilmour stated that ILAC's main global objective was to eliminate repeated testing as a technical barrier to trade by encouraging the establishment of Mutual Recognition Agreements (MRA's) between accreditation bodies.

ILAC also has specific objectives: to develop common criteria and harmonize practices, leading to regional multi-lateral MRA's and international MRA's.

He explained why there was a need for MRA's: these are in fact political imperatives, since confidence alone cannot be legislated. MRA's involve a network of bi-lateral agreements and multi-lateral arrangements; they must involve the implementation of ISO/IEC Guides and must also closely involve other organizations.

He stressed the growing importance of assuring traceability at both national and international levels because accreditation is of no use without accurate measurements; there is an ongoing need for NMI's to be able to prove their competence in this field.

Representing ISO, Mr. Anwar El-Tawil (Director of the Program for Developing Countries, International Organization for Standardization, ISO) said that there is a series of ISO Technical Committees (e.g. TC 12, TC 30, TC 48, TC 85, REMCO, CASCO) dealing with standardization of measuring instruments and measurement related activities; he stated that ISO Standards help manufacturers reach quality goals. Developing countries form the majority of ISO member countries, though not in terms of participation in ISO work; this point was developed in the Round Table - see below. DEVCO, the ISO Committee on matters concerning Developing Countries, has a comprehensive program for different aspects of standardization and related activities including publication of Development Manuals and organization of regional training seminars and fellowships.

Following these presentations, a Round Table discussion was held to conclude the Second Plenary Session; this was chaired by Mr. Terry Quinn (Director of BIPM).

The question was asked whether there will be increased collaboration between international organizations: Mr. Faber replied that there is definitely a need for closer cooperation between ILAC, the BIPM, the OIML, etc. Since our common goal is credibility in measurements, "strengthening cooperation is therefore necessary", ended Mr. Faber.

Photo: PTB

228 Delegates attended the Seminar - pictured here during a Plenary Session in the Stadthalle

Mr. Kovalevsky continued by stating that cooperation is necessary, but the WTO in particular should have contacts with these three main Organizations (i.e. BIPM, ILAC, OIML). Ms. Liu added that the WTO is very pleased that the OIML is now actively involved in their activities and the OIML now receives all WTO documents relating to TBT's. In reply to the question "Are MRA's the best solution (i.e. the final goal) in minimizing TBT's", Ms. Liu stated that the WTO will look closely into this matter and come up with guidelines, since some concerns have been raised regarding the non-transparency of some MRA's, which led to discrimination in certain collaborations.

A suggestion was also made that translation of standards into foreign languages may sometimes cause barriers to trade; ISO suggested that countries could perhaps work together to minimize such translation problems.

In reply to the question "How does ISO involve developing countries in the creation of international documents", Mr. Anwar El-Tawil replied that as mentioned previously, developing countries form the majority of ISO membership though not in terms of participation in meetings. ISO has created an intense sponsorship program - the DEVPRO - to help developing countries participate in ISO work, and is trying to convince national bodies to work more closely together.

The concern was raised that to achieve credibility in metrology, infrastructures are very important and large countries are much further ahead in this field than smaller ones, and the following question was asked: "Does the OIML have a program for technology transfers to smaller countries". Mr. Faber replied that the OIML Development Council constantly reviews its program in an attempt to bring countries together, and also widely circulates information to these countries.

Plenary Session 3

Wednesday, 17 June 1998

Mr. Hratch G. Semerjian (Director of Chemical Science and Technology Laboratory, NIST, USA) opened the Third Plenary Session by speaking about the impact of metrology on national economies and on international trade. Mentioning industry trends, he said that there was an increase in both global competition and trade and that there was a shift in research and development investments to a short-term focus. Technical barriers to trade are becoming increasingly important and as a result, so will the demand for infrastructural support. Mr. Semerjian noted that NIST has carried out a cost/benefits study on the importance of metrology.

He went on to say that to extend the global market, measurements and currencies that can be trusted are needed. Metrology has a very important impact on the economy - for example measurements of cholesterol, measurement of the oxygenates in gasoline and expert system control of metal powder atomization.

The prerequisites for success were traceability to national standards, comparability between national structures, and equivalency between them. What was needed was an implementation plan to achieve this.

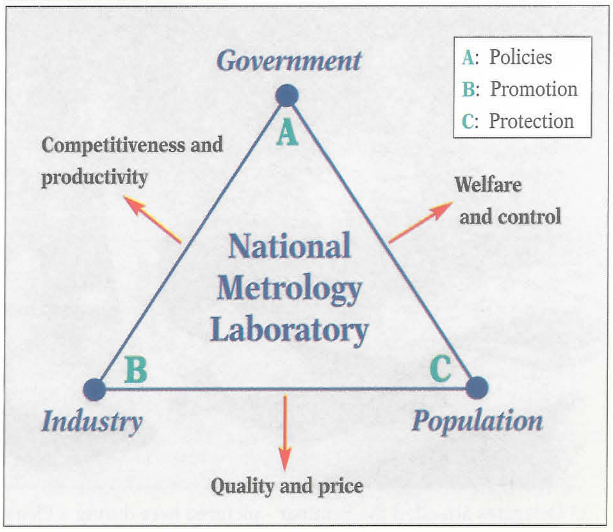
Mr. John Hobday (Director of the National Metrology Directorate, Department of Trade and Industry, DTI, United Kingdom) spoke about the DTI's role and its development of a cost/benefits strategy model to determine the significance of measurements in industry sectors.

Mr. Oscar Harasic (Coordinator for MSTQ at the Organization of American States, OAS) outlined the programs and projects of the Interamerican System of Metrology (SIM) which has 24 member countries and which coordinates the activities of the regional organizations NORAMET, CAMET, ANDIMET, SURAMET and CARIMET.

Mr. Harasic illustrated the impact of national metrology laboratories' policies (see Figure below) as regards global change.

Concluding Plenary Session 3, Mr. Octavio Maizza-Neto (Director of the Quality Unit of the United Nations Development Organization, UNIDO) said that since 1995 UNIDO assists developing countries in overcoming weaknesses in their quality, standardization and metrology (QSM) systems but stated that regrettably, in many developing countries metrology (i.e. the development of a metrological infrastructure) is not a high priority.

GLOBAL CHANGE



UNIDO recently carried out surveys on the trade implications of ISO 9000 (in 1995) and of ISO 14000 (in 1997). It transpired that there was an emergence of a new competitive global environment; the rapid increase in implementation and impact of the ISO 9000 series also led to greater demands on calibration services.

In concluding, Mr. Maizza-Neto highlighted the fact that between 5 to 10 % of worldwide exports are lost due to the non-equivalency of standards.

In the ensuing Round Table discussion chaired by Mr. Steve Carpenter (Director of International Relations, NIST, USA) various questions were posed concerning the papers presented in Plenary Session 3 and the following main points were raised:

- concern about the trend towards privatization and sub-contracting that counteracts impartiality and independence;
- training trainers is an important issue which can be more effective that traditional training;
- each developing country has to shape its own strategy for developing its metrological infrastructure;
- well-matched development projects (e.g. UNIDO project in Singapore) can be successful;
- specific and convincing cost/benefits studies on metrology services are needed;
- combined and harmonized efforts of international organizations are imperative to achieve positive results.

Plenary Session 4

Wednesday, 17 June 1998

Mr. Janko Drnovšek (Standards and Metrology Institute, SMI, Slovenia) presented a paper on establishing and organizing metrological infrastructures in a small country. A re-edited version of this paper is in fact printed in full in the *Evolutions* section of this Bulletin, as the Editors felt that reading about Slovenia's experience will undoubtedly be of use to many other OIML Members.

On the subject of establishing and organizing adapted metrological infrastructures in a country with an emerging economy, Mr. Mauricio Nogueira Frota (Director of the National Institute of Metrology, INMETRO, Brazil) highlighted developments which had been made in Brazil with a view to aligning policies in developing countries and strengthening regional cooperation within SURAMET and later within SIM.

Mr. Frota further emphasized the importance of the development of human resources in metrology, especially in developing countries.

Mrs. Ghaïet-El-Mouna Annabi (Director of Quality and Consumer Protection, QCC, Tunisia) then spoke about how a metrological infrastructure has been established and organized in a country which is very much oriented towards the food industry and tourism. Mrs. Annabi gave interesting facts and figures about Tunisia's economy and emphasized that much progress has been made.

Mr. Pavel Klenovsky (Director of the Czech Metrological Institute, CIM, Czech Republic) talked about the situation of another small country in transition towards a market economy which was facing problems and challenges in restructuring its metrological infrastructure and in joining European regional metrology organizations.

Mr. John Birch (Executive Director of the National Standards Commission, NSC, Australia) said that consumer protection is important, however we must also look at how metrology is applicable to manufacturers. He continued by explaining that there appears to be an 11:1 ratio for metrology - i.e. $11 saved for each $1 spent on verification. Much economic backwardness can be explained by the lack of mutual confidence. The economic benefits of trade measurement include consumer protection, control of fraud, reduced disputation costs, full collection of government taxes on commodities weighed, etc. Metrology also has a direct impact on many other areas that are not as easily quantifiable - such as road safety, where radar control, breath testers, speed cameras, etc. are commonly used.

Mr. Barry Inglis (Regional Coordinator of the Asia Pacific Metrology Program, APMP, Australia) took the floor and explained that the biggest challenge facing the APMP is global Mutual Recognition Agreements between National Measurement Institutions (NMI's) for equivalency of national measurement standards and mutual recognition of calibration certificates. In order to achieve this, key comparisons organized by the BIPM and the Consultative Committees have to be complemented by regional and inter-regional comparisons and implementation of programs for such comparisons at the national level.

Lastly, Mr. Inglis mentioned that it is not sufficient merely to have functional equipment, but it is also essential to understand how to use it most effectively and that traceability performed from reference standards by an unbroken chain of calibrations must be performed by competent calibration laboratories.

Finally in this session, Mr. Jie Gao (Deputy Director of the National Institute of Measurement and Testing Technology, CSBTS, China) evoked some facts and figures highlighting the benefits that the metrology law has brought in ensuring fair competition in a free market in China: 70 000 cases of laws being violated were investigated; 7 000 cases of metrological disputes were mediated and over $8.3 million confiscated and a loss of $21.7 million retrieved.

Mr. Gao concluded his presentation by stating that metrology is an important prerequisite in enhancing product quality.

The Round Table discussion which concluded this Session - chaired by Mr. Bernard Athané (Director of BIML) - brought up a number of interesting points concerning confidence: a lack of confidence towards certain laboratories due to the disparity in the levels of technology involved could create a TBT; peer evaluations and key comparisons may also need to be performed since trust is no longer sufficient in itself and can lead to TBT's through discrimination.

Mr. Hengstberger (NML, CSIR, Pretoria, Republic of South Africa) contributed to the discussions with a short presentation on Southern African regional cooperation in the field of metrology, standardization and related activities. (More information and details on the Southern African Development Community (SADC) cooperation in metrology can be found in the OIML Bulletin Number 3, July 1998).

Plenary Session 5

Thursday, 18 June 1998

Opening the Fifth and final Plenary Session, chaired by Mr. Andrew Wallard (National Physical Laboratory, NPL, UK), Mr. Dietrich Hofmann (Chairman of Technical Committee 1 "Education and Training in Measurement and Instrumentation", International Measurement Confederation, IMEKO, Germany) evoked new trends in education and training, including life-long learning and computer based training. There was perhaps no longer a need for books in this age of computers: virtual training centers, Internet teachware, laptop experimenting and remote laboratories were becoming common place.

Mr. Jozsef Kiss (Technical Director of Instrument, Measuring Technique Servicing and Trading Company Limited, MTA-MMSZ, Hungary) evoked an interesting concept developed and implemented by MTA-MMSZ: metrological equipment rental. Such a service minimizes maintenance and repair costs and allows equipment to be available throughout the country rather than only at a given location. Further, this innovation makes the purchase and utilization of expensive measuring instruments profitable; this is a concept which could be exploited by a number of countries, and may be especially useful for developing ones.

Leading on from this point, Mr. Salvado Echeverria-Villagomez (Physics Metrology Director, National Metrology Center, CENAM, Mexico) said that metrologists are convinced that metrology is relevant for solid economic development, however governments are not always willing to pay the required price.

Mr. Echeverria Villagomez gave some ideas as to how governments may be persuaded to increase their investments to the required level: showing success stories, making impact studies, lobbying and engaging in promotional campaigns, etc. In order for metrology to be of real benefit to users, more than just calibration is necessary.

Mr. Carlos Alberto Schneider (General Director of the Foundation for Centers of Innovative Technology, CERTI, Brazil) stated in his presentation that 75–85 % of small companies have insufficient knowledge of metrology. This is why between 1996 and 1998, the Human Resources Metrology Program invested $1 million in training people.

In conclusion he stated that the creation and maintenance of a metrological culture is essential for the competitiveness of SME's.

On the subject of training, Ms. Hilary McNeill (Director of the SEMAT Program of the National Physical Laboratory, NPL, UK) gave a presentation on the SEMAT secondments scheme, the objective of which is to encourage the exchange of experience and know-how between participating organizations, these being for the moment located in Central and Eastern Europe. Work on the SEMAT Program started in 1997.

Participating must be citizens of a EUROMET country that is becoming a EU member. The host organization provides the participant with a structured work program which may include joining an active research group, or carrying out test/calibration work. Over the past year there have been 11 secondments in total, and another 12 are pending. Benefits of the scheme include knowledge of new techniques, exchange of ideas, knowledge of EU practices, research experience, professional long-term links, etc. The program is to be expanded to Ukraine and Slovenia in 1998.

During the final Round Table session, a much debated question was that of the power of information technology (IT) to reduce costs and increase efficiency. Despite differences in the level of IT available in different countries (a point raised by the BIML) there should not be knowledge barriers between countries. Many small and medium sized companies and even some countries do not have access to the Internet; there is a need to work with organizations and manufacturers worldwide to evaluate the needs of different sectors. The first step in a developing country's improvement of metrology is the creation of an infrastructure that suits its needs.

Another important question was raised on the importance and the need for training in the field of metrology.

The final afternoon of the Seminar was taken up with Discussion Groups on specific aspects of metrology; a brief account of these is also included in this report.

▶ Conclusions

In his closing address Mr. Athané (Director of the BIML) emphasized that OIML activity must be adapted to match the work of the BIPM, IMEKO, ILAC, ISO, etc. and fulfill the needs of international organizations such as the WTO (especially its TBT activity), regional bodies, Member States and especially of developing countries.

This is the first time that the three large metrology Organizations have been able to discuss matters of such importance as those evoked during the Seminar, exchange views and discover more fully each other's activities.

Based on the outputs of this Seminar, work will be carried out by the OIML to propose new directions of activity in order to enhance the role of metrology in economic and social development. The conclusions of this work will be presented at the CIML meeting in Seoul, Korea, in October 1998.

Mr. Seiler pursued by mentioning that the motivation for holding the Seminar was to raise awareness of decision makers and to inform industry of the necessity for accurate measurements by providing specific examples of successes and problems and giving a satisfactory response. He was very encouraged that seventeen international and regional organizations had sent representatives coming from over 80 countries with a total attendance of over 220 participants.

Lastly, Mr. Göbel evoked the need for an efficient information flow both within developed countries and within those in transition, and suggested that the best way to transfer knowledge is still face-to-face.

Many of the Delegates also attended technical visits to the PTB on Friday, 19 June and were impressed by the efficiency of the organization of the Seminar. Participants will return to their own country in the knowledge that much has already been done in the field of metrology but even more remains to be done to ensure that metrology really does continue to play an essential role in economic and social development. ■

Accounts of certain discussion groups

Group 1 Accreditation of Laboratories

Group 1 was chaired by Mr. Volkmar Kose (PTB Past Vice-President) and discussed a number of aspects of laboratory accreditation:

- requirements for accreditation bodies and accreditors;
- how to prepare laboratories for accreditation;
- what is the role of accreditation of laboratories for certification within metrology;
- acceptance of calibration and conformity test certificates;
- accreditation of legal metrology laboratories; and
- approach to Certified Reference Materials (CRM's).

Mr. Kose drew the conclusion that to prove the competence of a laboratory, the best solution is accreditation according to the requirements of ISO Guide 25 (in the future ISO Standard 17025) and in order to create confidence it would be desirable for the traditionally notified laboratories of NMI's and Legal Metrology Institutions to be themselves accredited.

Group 3 The Role of Professional Associations in Metrology

Six representatives participated in this group: Mr. M.N. Frota of the Brazilian Society of Metrology (Chairman), Mr. L. Fernandez of the Chilean Metrology Association, Mrs C.D. Briseño of the Mexican Metrology Association, Mr. I. Temniskov of the Bulgarian Metrology Association, Mr. M.L. Saidi from Tunisia (which does not yet have a formal Association) and Mr. M. Borsic of the Croatian Metrology Society.

These Associations are predominantly non profit-making and are for the main part not government funded (see individual accounts, below); individuals as well as laboratories or organizations may become members and the aim is to further knowledge of metrology as widely as possible by means of publications, conferences and technical advice - i.e. to promote "intellectual production" in metrology, though the objective is not to compete with metrological institutions as associations do not possess laboratories and do not carry out accreditation. A long-term goal may be the creation of a new international union of professional associations.

The ***Brazilian Society*** recently launched a newsletter and aims to develop culture in metrology; it wants to develop more scientific institutions. Launched in 1996, there are over 1 000 affiliates, 5 books have been published and 3 schools of metrology organized.

The ***Mexican Association*** was created in 1988 due to a lack of qualified metrologists in Mexico - Mexican industry needed these skills and those active in the field came together to support a national accreditation program, spread knowledge, stimulate and promote communication and encourage the growth of the national calibration system. Scheduled open courses (50 to date) and national/international annual congresses and conferences are held (15 to date), advice is given to industry and technical information distributed.

The ***Chilean Association*** has 45 company members and 4 individual members; in fact the State is an affiliate association and Chile is implementing a network of laboratories within national companies.

The ***Bulgarian Association*** has created a company to provide consultancy on accreditation and charges for this service, a strategy which has often helped unemployed metrologists to re-integrate their profession. Every two years an International Conference is held in Bulgaria. The Association was created in 1990 and has over 1 000 affiliates.

Tunisia has created a National Council of Metrology and whilst it does not have an Association, it does have many legal metrology institutes; these concentrate efforts on the Institute of Normalization. University members and professional association members meet regularly in a Committee to plan the introduction of the National System of Metrology.

The ***Croatian Society*** (HMD) has 289 individual members and 51 laboratory members or organizations as affiliate members. A number of major international seminars and workshops have been organized, and 83 quarterly bulletins and 178 papers have been published. The HMD also contributes to the formation of Croatian technical regulations and to the establishment of the Croatian technical authority. Six books have also been published.

The consensus reached by the meeting was reported by the Chairman Mr. Frota, who summarized the major outcomes as follows:

- In spite of the great efforts made by NMI's, independent professional metrology associations have an important role to develop in disseminating metrological culture and in complementing the actions of the former;
- Associations have a key role in verifying and controling (on behalf of society) whether the NMI's are actually developing the metrological work they set out to accomplish;
- Associations play an independent role without generating conflicts of interest.

Speech by Mr. Gerard Faber, CIML President

Mr. Chairman, Ladies and Gentlemen,

Let me first associate myself and the OIML with what has been said concerning this International Seminar. I will perhaps avoid describing this event as "unique" just because I hope that this kind of opportunity will take place again in the future. Nevertheless, I want to underline the fact that, for the very first time, three international bodies responsible for various aspects of metrology - and one national metrology body - are very closely associated in the organization of this Seminar, in which a number of other international and regional organizations have accepted to participate, together with representatives of many countries. I am certain that this meeting will therefore constitute a key event and serve to further international cooperation in metrology and metrology-related activities.

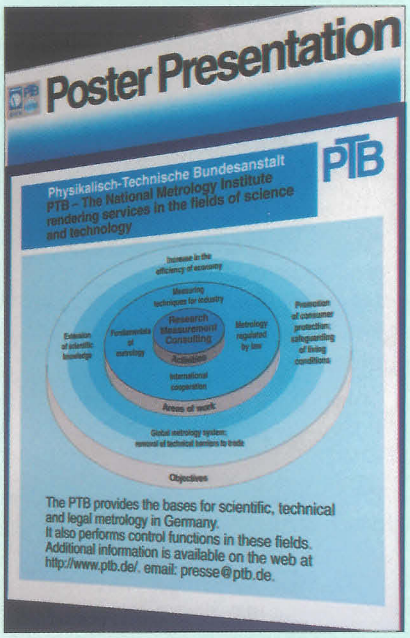
Just as the representatives of the other international organizations, I have been requested to present you the OIML program in less than twenty minutes. Therefore, I will refrain from entering into a lengthy description of the OIML: for those of you who would like information concerning OIML general activities, please refer to our brochure which is available for all of you.

Some of the posters presented by international and regional Organizations, Institutions and others, showing their activities

WELMEC and DAM posters

NWML, MTA-MMSZ and ICMET posters

BIML Staff with the OIML posters. *Left to right:*
Attila Szilvássy, Nathalie Dupuis-Désormeaux, Chris Pulham



PTB poster

General view of other posters

I will therefore limit myself to giving you information and remarks which are directly related to the topics of this Seminar - information and remarks which will in fact cover three main topics:

- firstly, some general views concerning legal metrology and its role in economic and social development; as far as this is concerned, I hope that I will not contradict what will be said by John Birch on Wednesday afternoon;
- secondly, the relevant role and program of the OIML;
- and finally some views and recommendations as to the possible outputs of this Seminar concerning the most advisable developments of legal metrology in various countries.

Legal metrology covers all the fields of metrology where controls are exercised by or on behalf of governmental authorities, in order to ensure an appropriate level of credibility of measurement results in a regulatory manner.

These fields are those where the protection of human beings and of society as a whole implies paying special attention to measurement results on the part of public authorities, as well as areas where conflicting interests in measurement results exist, thus necessitating the intervention of an impartial referee. It should be noted that in many cases both aspects coexist, i.e. protection and conflicts.

In fact, generally speaking there are five main areas where legal metrology intervenes:

a) Trade

This includes retail trade where consumer protection is of prime importance and where conflicting interests may exist between buyers and purchasers; wholesale trade where strong conflicting interests may sometimes exist; and international trade where it is the economy of a whole country which has to be protected.

b) Health

An increasing number of measuring instruments and methods are used in medical diagnosis and care, including temperature, blood pressure or ionizing radiation measurements, electroencephalographs and cardiographs, blood analysis, ergometry, etc. These are fields where accurate measurements are sometimes not easily obtainable, and where most often those who use measuring equipment are not specialists in metrology; the need to ensure credible measurement results is, literally, vital for patients.

c) Safety issues

This includes for example measurements of the speed of vehicles, axial load of trucks, influence of alcohol on drivers and workers, light and noise levels at the place of work, etc. where both protecting people and eliminating conflicting interests are the reasons for developing legal metrology controls.

d) Environmental protection

There is also an obvious need for accurate and credible measurements, not only with a view to protecting human beings, livestock and agriculture, but also to solve potential conflicts which may exist with all those who cause pollution, especially in the fields of industrial processes, energy production, mining, transportation, etc., bearing in mind the cost of depollution or that of non-pollutive production.

e) Official controls

Last but not least it is essential for public authorities to apply sound metrological rules in for example the establishment of taxes and surveying, which are two examples of official controls which spring to mind; the same must of course apply to any activity connected with metrological control.

These are the main areas where legal metrology plays a key role, but this does not necessarily mean that at the level of each individual country, the so-called legal metrology service is responsible for the totality of the relevant tasks.

In fact, many national bodies exist within ministries responsible for trade, industry, health, justice, customs, the environment, etc., where legal metrology activities are carried out without always first establishing the necessary "interconnections", and without even the notion that such activities are part of legal metrology. This is a problem which must be solved to ensure sound and coherent development of legal metrology at national level and to ensure the success of OIML activities at international level.

I will come back later to this essential matter and give you my views concerning the need for comprehensive national metrology infrastructures.

But before that, I would like to wrap up this first part of my presentation by coming back to the role of legal metrology in economic and social development.

By contributing to fair international trade of products and services, legal metrology also contributes to countries' economic development. This is true for industrialized countries, which have the necessary expertise to accurately determine the value of the products and services they import or export, through quantitative and qualitative measurements. This should be even more true for developing countries, whose economy is often based on the production of a limited number of agricultural products, minerals, crude oil, etc., and which have to import many manufactured goods, products and services. Industrial companies which exploit or purchase these resources, as well as import-export companies, know quite well how to perform relevant measurements and how to ensure that measurement uncertainties will not be detrimental to them: this means that they might be detrimental to the economy of developing countries.

By contributing to a fair evaluation of the value of products that are subject to taxes, legal metrology also contributes to a correct evaluation of national incomes.

By contributing to fair retail trade of products and services, legal metrology also contributes to the protection of consumers' purchasing power and hence to their ability to purchase more, which in turn accelerates economic development.

And by contributing to the credibility of measurements in health diagnosis and care, in the detection of pollution levels in our environment and in many other actions connected with the maintenance of appropriate levels of safety, legal metrology also contributes to the welfare of human beings and to the general equilibrium of society.

You will notice that I have systematically used the word "contribute". In fact, nobody imagines that legal metrology can by itself ensure the economic and social developments that I have talked about. Legal metrology is just one of the necessary components, and its success will depend upon a successful interaction of various components.

In order to limit myself to purely metrology matters, I will just mention briefly, among these components, the need for all measurements to be traceable to sound national measurement standards whose international equivalence is ensured by the bodies under the *Convention du Mètre*.

Let me now move on to the second part of my presentation, which concerns certain aspects of the OIML program.

One of the main technical goals of the OIML is to harmonize existing national and regional legal metrology regulations, bearing in mind that such harmonization has two objectives:

- to eliminate technical barriers to the trade of the measuring instruments concerned;
- to facilitate the trade of products and services of which the commercial value is based on measurements.

These objectives must be attained while maintaining the quality of the measuring instruments concerned at an appropriate level, but still allowing for technical progress.

This is done by implementing OIML Recommendations which are developed in terms of metrological performances to be reached, and testing procedures to be carried out.

OIML Recommendations cover a wide variety of measuring instruments; however, the technical program of the Organization was reviewed some years ago in order to concentrate on instruments actually used in the five main fields of legal metrology that I have described.

OIML technical activity continues to develop by covering additional categories of measuring instruments whenever technical progress leads to the conception of new measurement techniques; however, a large part of this activity now consists in reviewing and updating existing Recommendations. This is due to the fact that a number of OIML Recommendations which are now some ten years old had been developed more in terms of technical solutions to be applied than of metrological performances to be reached. Therefore, technical progress rendered them obsolete. In addition, testing procedures are absent from most of these old Recommendations which therefore merit a rapid revision.

Based on these Recommendations, the OIML Certificate System for Measuring Instruments is a step forward in the application of the one-stop testing concept to measuring instruments subject to legal control. The System is now well accepted by both manufacturers and by OIML Members. More and more manufacturers from more and more countries now apply for OIML certificates in fields such as weighing instruments, gasoline pumps or gas meters. With the issue of new Recommendations covering, for example, breath analyzers, we expect that manufacturers of such instruments will also prove their interest for OIML certificates. This will result from the fact that national legal metrology services of more and more countries accept to accelerate the granting of national or regional pattern approvals on the basis of OIML certificates and associated test reports. However, further progress should be made in the acceptance of OIML certificates through, for example, bi- or multilateral recognition agreements, or the accreditation of laboratories that perform legal metrology testing. These are matters on which the OIML is now working actively.

Concerning developing countries, the OIML Certificate System is of vital importance in so far as it enables those countries which do not have the facilities for performing pattern evaluation to replace it by the acceptance of OIML certificates. The problem of initial verification of individual instruments has still to be considered, but I believe that the OIML System will develop within some years to solve this problem.

I have spoken about certain aspects of the technical activity of the OIML. But our Organization should not be considered as purely technical. It has already - and will increasingly have in the future - an activity which I would qualify as being political.

Through its International Documents and other appropriate means, the OIML has already started to advise governments on the best ways to develop sound legal metrology policies, integrated into comprehensive metrological infrastructures. In so doing, we do not want to interfere with governmental prerogatives, but rather ensure that harmonized guidelines are followed within national or regional policies.

We will have to amplify this kind of action in the future, and quite probably conduct it in closer cooperation with the other international and regional bodies concerned. This Seminar, where representatives of countries and of international and regional bodies are represented, is obviously an efficient way to challenge governments to recognize the role of metrology in economic and social development.

This leads me to the conclusion of my presentation.

Of course, I do not want to anticipate the results and output of this Seminar. However, since very unfortunately I will not be present on Thursday when conclusions will be drawn, I would like to submit some views for your consideration.

I will start with what the scope of legal metrology should be.

I have defined what legal metrology is and consequently what the OIML technical program should be.

It is my conviction that at national level, the scope of legal metrology should not extend beyond the limits of the OIML technical program, except in some very specific and justified cases.

I understand quite well that, for many countries that are now moving towards a market economy, it may be difficult to abandon practices dating from the time when all kinds of measuring instruments were submitted to regulations. Such a drastic change affects employment within the legal metrology services, and may also affect manufacturers - for whom legal controls were a kind of free quality assurance system.

We are in a period of deregulation, and as a consequence we must not over-regulate metrology, if we wish to maintain credibility in legal metrology.

If now I consider developing countries, after having evoked the role of legal metrology in their economic and social development, I would like to advise them to be very careful in deciding about the directions of legal metrology developments. In many of these countries, it is not possible to develop everything at the same time, and so appropriate priorities must be defined. The fact that legal metrology has developed in industrialized countries in a context of fair trade (now understood as consumer protection) does not mean that a similar development is appropriate for developing countries. It should be envisaged to focus on those measurements which have the maximum impact on economic development, before extending legal metrology to other areas.

In my presentation, I have on at least two occasions mentioned the need for appropriate national metrology infrastructures, and I would like to ask you to reflect carefully on this subject.

I am convinced that the various aspects of metrology - maintenance of primary measurement standards, traceability systems, measurements in the various fields of human activity, metrology research and training, and of course legal metrology - must not develop independently.

There is a need for what could be referred to as a national metrology infrastructure or system, with the role of ensuring the necessary coherence between the various metrology activities carried out at the level of a country.

In my opinion, there is no unique pattern for such an infrastructure and it is more the objective than the form which must lead policy makers in their establishment, and it may be as simple as a coordinating council with representatives of the various ministries and other interested bodies.

Last but not least, all these activities and developments at national level must have their counterparts at regional and international levels.

Regions are essential tools for coherent development and cooperation. Any country should participate in a regional metrology forum, or possibly several fora, for example one for basic metrology and one for legal metrology.

The international level is then the ultimate stage of cooperation, where countries decide about the general rules they will implement at regional and national levels.

If I consider what has been achieved by the three international metrology organizations which have cooperated in the preparations for this Seminar, I think that I can express a real degree of satisfaction. Lot of things have been done, but lot of things still remain to be done.

We must however be aware that financial resources must be used as carefully as possible. This means that closer cooperation must exist between international and regional organizations as well as between international organizations, with a view to better coordinating activities and, through a synergetic effect, doing more with the same resources. In fact, the national metrology infrastructures which I recommend all countries to establish could have a ricochet effect at international level.

Mr. President, Ladies and Gentlemen,

I am convinced that this Seminar organized in Braunschweig by the Physikalisch-Technische Bundesanstalt and three international metrology organizations will have many positive results. Firstly at national level, it should result in a better understanding by policy makers of the role of metrology and the necessity to allocate appropriate resources to this discipline. It should also result in the development and rationalization of appropriate and efficient national metrology infrastructures. Concerning developing countries, this Seminar should be an opportunity for defining the needs and identifying sources of assistance. And last but not least, this Seminar should act as an incentive for international and regional bodies to better coordinate their actions.

As President of the International Committee of Legal Metrology may I assure you that the OIML is willing to develop cooperation with any relevant international or regional body, and will duly take into consideration the output of this Seminar in the preparation of its future strategy.

Thank you for your attention.

Gerard Faber

IMEKO PTB OIML BIPM

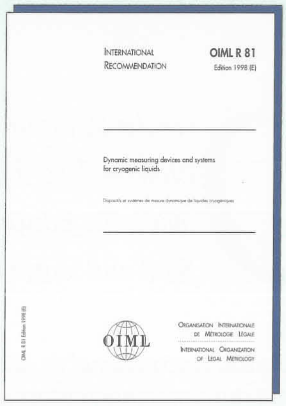
INTERNATIONAL SEMINAR

The Role of Metrology in Economic and Social Development

Braunschweig, Germany 16–19 June 1998

New OIML Publications

The English versions of the following publications are now available:



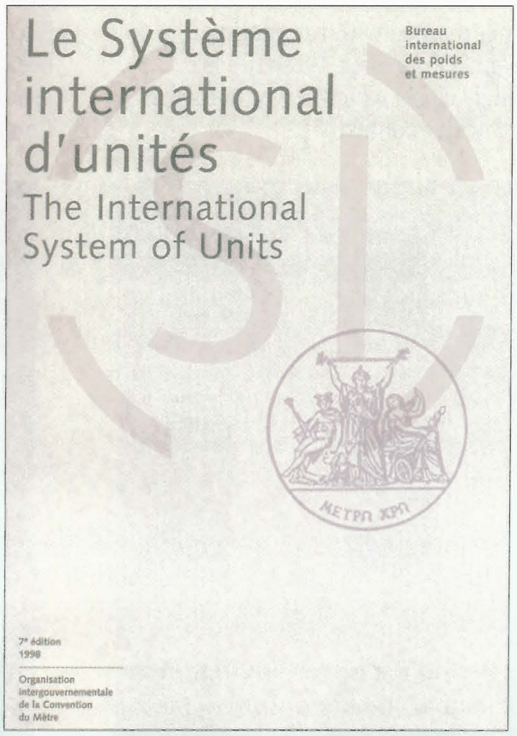
R 81 **Dynamic measuring devices and systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)**

D 2 **Legal units of measurement**

Now available:

International System of Units

7th edition (1998)



BIML in perspective

Over the last four years since the publication of our article in the July 1994 issue of the OIML Bulletin describing BIML activities and the roles of its Staff, a number of changes have taken place; the Editors therefore felt it would be of interest to readers to introduce new Members of Staff and summarize the Bureau's activities.

The *Bureau International de Métrologie Légale* is the **Secretariat** and headquarters of the OIML, ensuring both the day to day running of activities and the planning of longer term actions.

The BIML coordinates and informs CIML Members of **technical work** undertaken by OIML Technical Committees (of which there are 18), organizes OIML Conference and Committee **Meetings** and manages the **finances** of the Organization.

Liaisons are also maintained with International, Regional and National Organisms; these ties are becoming increasingly close, which serves to further legal metrology in a wider context.

Another key aspect of BIML work is the issuing of **OIML Publications**: Recommendations, Documents, Vocabularies, and of course the quarterly **Bulletin**.

All translation, editing, proof-reading and layout are now carried out in-house in an effort to reduce costs, increase productivity and reduce the risk of printing errors.

As an example, the lead-time for producing Recommendations approved by the Committee has been cut by almost half and the same applies to the production of the Minutes of OIML Meetings and Conferences.

BIML offices, Rue Turgot, Paris 9th - just 5 minutes' walk from the Sacré Coeur (viewed from the Bureau window)

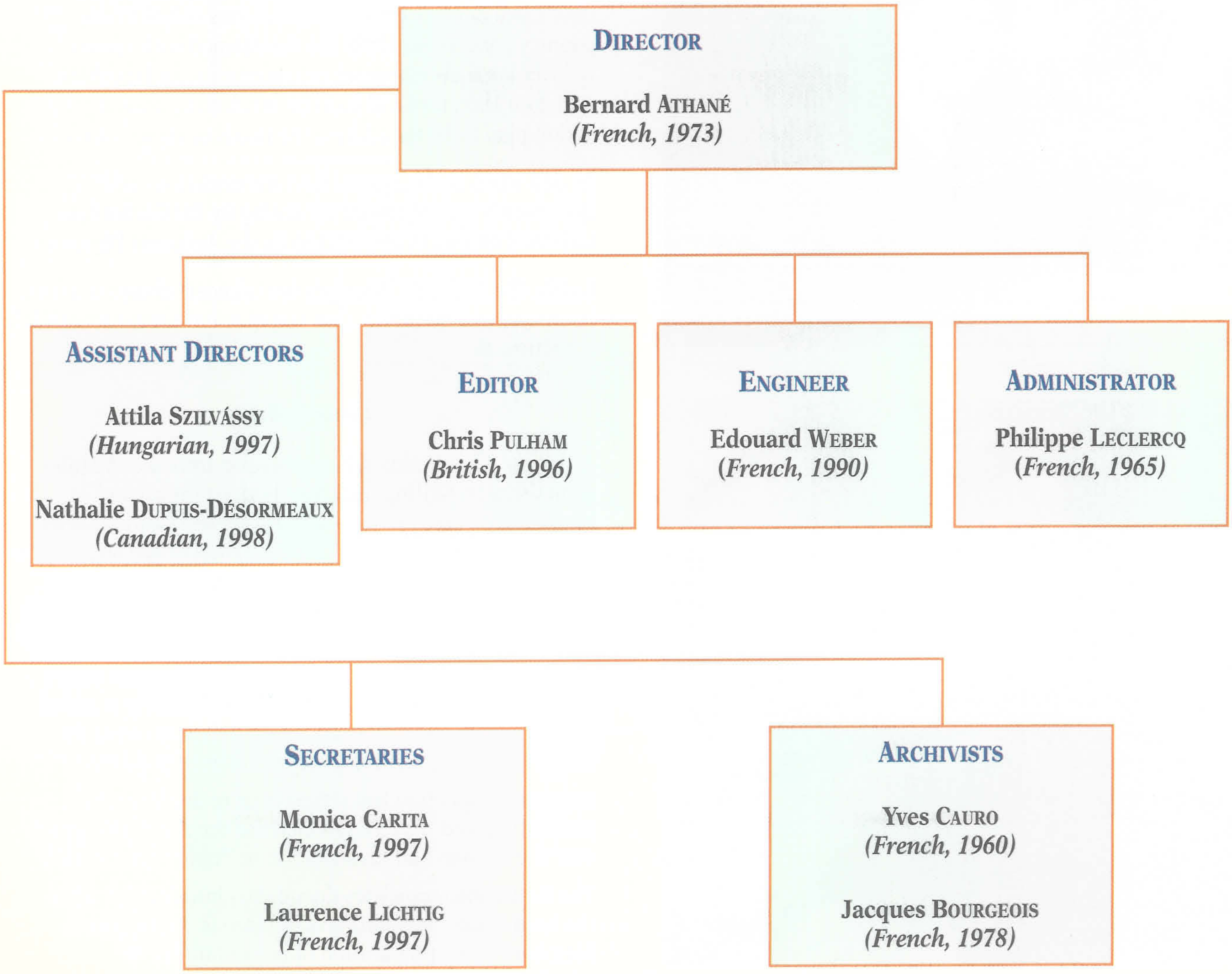
The BIML **Documentation Center** houses numerous technical documents, information booklets and data on manufacturers, as well as stocks of OIML Publications. Although this Center is not open to the public, Members may request information by mail.

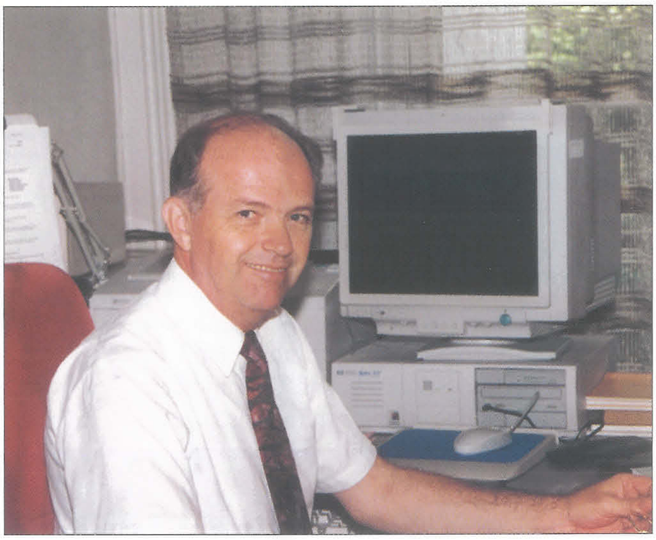
Details of OIML Members, Publications and activities may also be obtained via our **Internet** site which came on line in 1997. Find us at **www.oiml.org**

The **OIML Bulletin** is edited and produced by BIML Staff - circulation is approximately 1300 copies, sent free of charge to Members and by subscription to manufacturers and other interested parties. The Bulletin is regularly re-styled to keep up with technological developments, and contributions emanate from a wide range of professional metrologists throughout the world. Articles frequently feature the state of development of metrological activities in various countries - of particular interest are those written by Members of **Developing Countries**, who constantly strive to improve the services and facilities they offer for legal metrology activities such as type approval testing and verification as well as for calibration and accreditation.

The **Staff** at the BIML are limited in number - ten people are employed as described below. This number has not increased over time, despite an increased workload and ever-increasing number of Members.

BIML Organization Chart





Attila Szilvássy and Nathalie Dupuis-Désormeaux

As Assistant Directors, Attila Szilvássy and Nathalie Dupuis-Désormeaux are responsible for closely monitoring TC/SC activity, including providing technical advice when necessary, and participating in TC/SC meetings. Reports on these are regularly drawn up and published in the Bulletin, and accounts are given to CIML Members at the annual meeting in October.

Key OIML documents are reviewed in order to adapt them more closely to the aims of the OIML and the expectations of its Members, training sessions and technical seminars relevant to the activities of the TC's are organized or co-organized, the progress of the OIML Certificate System is monitored and the communication and promotional strategies of the OIML are constantly updated. As and when required, liaisons are also created and maintained with other organizations in support of these activities.

When a developing country or country in transition towards a market economy becomes more involved in OIML activities, the two Assistant Directors may help in the development of metrological structures suited to the country concerned. Links are maintained with various international development organizations, and the BIML Assistant Directors will soon be involved in drawing up an action plan to better address the needs of these countries.

As and when International Recommendations and Documents are submitted for voting by the Committee, technical editing is undertaken by the Assistant Directors.

Lastly, the Assistant Directors are (almost) always available to answer any questions that you may have regarding OIML activities. ■

Chris Pulham

As Editor, Chris Pulham is responsible for selecting (and sometimes co-writing) articles - both technical and informative - together with accompanying illustrations for publishing in the Bulletin; these are then edited and laid out in the *QuarkXPress Passport* desktop publishing package.

Chris also edits all OIML Publications before printing (e.g. Recommendations, minutes of meetings, event programs, exhibition posters, etc.), and some circulars to Members. Wherever possible, a certain degree of creativity is added and all documents produced are entirely laid out at the BIML - assuming the computer is having a good day!

In-house production has served both to decrease the production lead time and to increase the Bureau's control over the content and presentation of Publications issued.

The Editor also translates documents into English when the need arises, and editing assistance is often given to Members in the preparation of presentations. ■

Edouard Weber

Edouard Weber is the BIML computer expert - when new equipment is installed (or when the old equipment goes wrong!) Edouard intervenes. The OIML now has its own Internet site (**www.oiml.org**) which is regularly updated with Members' Institutions and addresses, Publications and information on the Organization. The Bureau is also now linked to e-mail, and databases are being developed (for example for OIML certificates) in order to improve services offered to interested parties.

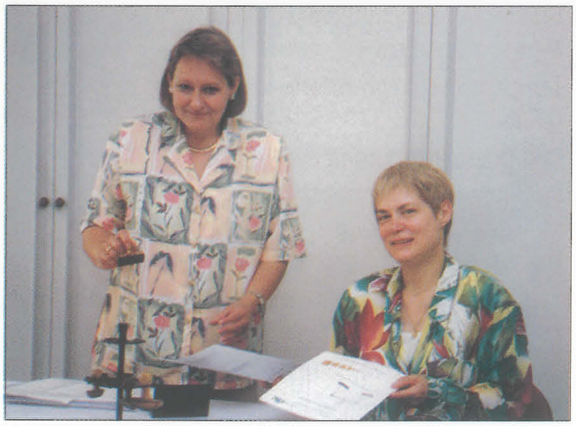
Edouard also translates OIML Publications into French, the Organization's official language. A considerable amount of editing work is also involved in this field. ■

Philippe Leclercq

Philippe Leclercq is the BIML Administrator, and is one of the longest-serving members of Staff. He is responsible for OIML Members' accounts, customer and supplier payments (sales and purchases) and also handles administrative and personnel matters including BIML staff records.

Philippe also handles certain activities associated with the Bulletin, such as updating the mailing list of subscribers and collecting subscription payments.

Maintenance of the OIML Offices (which have recently partially been refurbished) is also his responsibility. ■



Monica Carita (left) and Laurence Lichtig

The BIML's two secretaries, Monica Carita and Laurence Lichtig, are both bilingual English-French. They operate the switchboard, take shorthand dictation, type reports, organize mailings and circulars, distribute OIML publications and reply to inquiries for information.

A log is kept of all outgoing mail - of which there is a considerable quantity - and all incoming mail is filed according to Member or Institution.

Monica and Laurence are your first point of contact at the BIML, and provide information to numerous callers every day. ■

Yves Cauro (left) and Jacques Bourgeois

Yves Cauro - another long-standing member of staff - and Jacques Bourgeois are responsible for maintaining the archives in the documentation center, which occupies the majority of the BIML office's basement. Every piece of information is carefully identified, computer-recorded and filed for future reference.

Another important task is document production - the BIML's three photocopiers work virtually non-stop throughout the working day. ■

MÉTROLOGIE 99

18–21 octobre 1999 à Bordeaux

Le 9ème Congrès International de Métrologie aura lieu à Bordeaux du 18 au 21 octobre 1999. Il est organisé par le Collège Métrologie du Mouvement Français pour la Qualité (MFQ), avec le concours du Bureau National de Métrologie (BNM) et la participation scientifique de la Physikalisch-Technische Bundesanstalt allemande (PTB).

L'objectif de **Métrologie 99** est de faire le point, tous les deux ans, sur les techniques d'étalonnage et de mesure originales développées ou en cours de développement pour répondre aux besoins de l'industrie. Le Congrès présentera les évolutions de la fonction métrologique et son implication dans l'industrie, l'économie et la qualité, au niveau national et international.

Métrologie 99 sera un carrefour d'échanges des informations, des idées et des expériences permettant de faire progresser les techniques de maîtrise des processus de mesure. Ce Congrès exposera l'apport de la métrologie à l'économie de l'entreprise.

La métrologie "virtuelle", liée aux mesures de satisfaction des clients, aux sondages d'opinions, etc., sera aussi abordée.

Participent au Congrès tous ceux qui souhaitent suivre les évolutions techniques et organisationnelles pour guider leur stratégie en matière de qualité des produits, et recherchent des solutions pour satisfaire aux exigences du marché au moindre coût.

Plus de 500 personnes ont participé au Congrès de 1997, dont une majorité d'industriels.

La sélection des conférences sera réalisée par un Comité Scientifique et Technique.

Les conférenciers pourront présenter leur sujet soit en français, soit en anglais et une traduction simultanée sera assurée.

Thèmes du Congrès:

- Incertitudes de mesure
- Instruments de mesure
- Traçabilité, étalonnage et vérification
- Procédés de mesure et d'essais
- Capabilité des moyens de mesure
- Maîtrise des processus de mesure
- Organisation de la fonction métrologique dans l'entreprise
- Normalisation en métrologie
- Métrologie légale
- Formation, qualification du personnels
- Aspects économiques
- Métrologie virtuelle.

Les conférenciers auront la possibilité de développer ces thèmes soit d'une manière générale, soit en les appliquant à des domaines spécifiques:

- Dimensionnel
- Masse, force, pression, accélération
- Electricité, magnétisme
- Temps, fréquence
- Température, hygrométrie
- Débits
- Radiométrie, photométrie
- Rayonnements ionisants
- Mesures chimiques
- Emission et immission de polluants
- Métrologie de l'environnement
- Mesures en oenologie
- Mesures en agro-alimentaire
- Mesures dans le milieu médical.

La date limite de réception des propositions de conférences est fixée au 30 novembre 1998.

Métrologie 99 sera complété d'une exposition de matériel métrologique (50 stands environ sur le lieu du Congrès) et de visites d'entreprises de la région de Bordeaux.

http://www.mfq.asso.fr

MÉTROLOGIE 99

18–21 October 1999 in Bordeaux

The 9th International Metrology Congress will be held in Bordeaux (France) from 18th to 21st October 1999, organized by the Collège Métrologie of the Mouvement Français pour la Qualité (MFQ) under the aegis of the Bureau National de Métrologie (BNM) and with the scientific participation of the Physikalisch-Technische Bundesanstalt (PTB).

The aim of **Métrologie 99**, which takes place every two years, is to highlight new techniques of measurement and calibration that have been or are being developed to respond to industry's needs. The Congress will present the evolution of the metrological function within firms, together with its implications for industry, for the economy and for quality, at national and international levels.

Métrologie 99 will be a meeting place for the exchange of information, ideas and personal experiences enabling advances to be made in the control of measurement procedures. This Congress will explain the contribution of metrology to companies' economies.

"Virtual" metrology, linked to the measurement of customer satisfaction, opinion polls, etc., will also be studied.

Delegates attending the Congress will be those who wish to follow technical and organizational evolutions in order to focus their product quality strategy, and who are looking for solutions to meet market requirements at the lowest possible cost.

Over 500 people participated in the 1997 Congress, of which the majority were industrials.

The selection of papers will be made by a Scientific and Technical Committee.

Speakers will be able to present their papers either in French or in English, and simultaneous translation will be provided.

Congress themes:

- Measurement uncertainties
- Measuring instruments
- Traceability, calibration and checking
- Measurement and testing procedures
- Capability of measurement facilities
- Measurement procedures control
- Organization of the metrology function within the firm
- Standardization in the field of metrology
- Legal metrology
- Employee training and qualifications
- Economic aspects
- Virtual metrology.

Speakers have the possibility of developing those topics either in a general way or by applying them to a specific field:

- Length
- Mass, force, pressure, acceleration
- Electricity, magnetism
- Time, frequency
- Temperature, hygrometry
- Flow measurement
- Radiophotometry
- Ionizing radiations
- Chemical measurements
- Emission and imission of pollutants
- Metrology of the environment
- Measurements in oenology
- Measurements in the food industry
- Measurements in the medical field.

The deadline for receiving proposals is November 30th, 1998.

Métrologie 99 will be complemented by an exhibition of metrological equipment (50 stands located at the Congress venue) and visits to firms in the Bordeaux area.

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OIML meetings réunions

October 1998

28	OIML Development Council meeting	SEOUL, REPUBLIC OF KOREA
28–30	33rd CIML meeting	

November 1998

16–17	TC 8/SC 5 Water meters	PARIS, FRANCE
26–27	TC 1 Terminology	WARSAW, POLAND

February 1999

8–11	TC 8/SC 7 Gas metering	BRUSSELS, BELGIUM

March 1999

5	TC 13 Measuring instruments for acoustics and vibration	FRANKFURT, GERMANY

The OIML is pleased to welcome the following new:

CIML Member for Austria:	**Mr. Arnold Leitner**
CIML Member for Egypt:	**Prof. Ali A. El-Naggar**
CIML Member for Sweden:	**Mr. Sven Nyström**
CIML Member for Zambia:	**Mr. Fredrick M. Sinyangwe**
Corresponding Member:	**Guatemala**

info

Pressure Metrology from Ultra-high Vacuum to Very High Pressures (10^{-7} Pa to 10^{9} Pa)

3rd CCM International Conference

Torino, Italy

3–7 May 1999

The focus of this Third CCM (Consultative Committee for Mass and Related Quantities) Conference will be on the research activities aimed at achieving the highest quality primary standards and at the dissemination of the pressure unit to the most demanding users.

Conference language: English.

Main topics

- **Primary standards for low, medium and high pressures**
- **Physical properties and phenomena relevant to vacuum and pressure metrology**
- **Transfer standards and advanced sensors for pressure and vacuum metrology**
- **Pressure and vacuum comparisons at international and regional levels**
- **Traceability, dissemination, calibration and accreditation services for pressure and vacuum measurements**
- **Pressure and vacuum metrology in Developing Countries**

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OIML

OCTOBER 1998

This list of OIML publications is classified by subject and number. The following abbreviations are used:

R International Recommendation;
D International Document;
V Vocabulary;
P Miscellaneous Publication.

Publications are available in French and English in the form of separate documents, unless otherwise indicated. Prices are given in French Francs and do not include postage. "NC" indicates "no charge".

OIML publications are available either from the BIML (see address above) or from national sale points in the countries listed below (please contact the relevant CIML Member at the address given in this document).

National Sale Points:

▶ UNITED KINGDOM

Cette liste des publications OIML est classée par sujets et par numéros. Les abréviations suivantes sont utilisées:

R Recommandation Internationale;
D Document International;
V Vocabulaire;
P Autre Publication.

Ces publications sont disponibles en français et en anglais sous forme de fascicules séparés, sauf indication contraire. Les prix sont donnés en Francs Français et ne comprennent pas les frais d'expédition. "NC" signifie "gratuit".

Les publications OIML sont disponibles soit auprès du BIML (adresse ci-dessus), soit auprès des points de vente nationaux dans les pays mentionnés ci-dessous (contacter le Membre du CIML à l'adresse donnée dans ce document).

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P.O. Box 11836
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Avenida Italia 6201, CP. 11500
Montevideo

S. R. VIETNAM
Directorate for Standards
and Quality (STAMEQ)
70 Tran Hung Dao St.
Hanoï

General
Généralités

R 34 (1979-*1974*) .... 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 42 (1981-*1977*) .... 50 FRF
Metal stamps for verification officers
Poinçons de métal pour Agents de vérification

D 1 (1975) .... 50 FRF
Law on metrology
Loi de métrologie

D 2 (1998) .... 80 FRF
Legal units of measurement
Unités de mesure légales

D 3 (1979) .... 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

D 5 (1982) .... 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

D 9 (1984) .... 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

D 12 (1986) .... 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) .... 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) .... 60 FRF
Training of legal metrology personnel - Qualification - Training programmes
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 (1986) .... 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 (1986) .... 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

D 19 (1988) .... 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) .... 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

V 1 (1978) .... 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) .... 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français- anglais)

P 1 (1991) .... 60 FRF
OIML Certificate System for Measuring Instruments
Système de Certificats OIML pour les Instruments de Mesure

P 2 (1987) .... 100 FRF
Metrology training - Synthesis and bibliography (bilingual French-English)
Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)

P 3-1 (1996) .... 400 FRF
Legal metrology in OIML Member States
Métrologie légale dans les États Membres de l'OIML

P 3-2 (1996) .... 300 FRF
Legal metrology in OIML Corresponding Members
Métrologie légale dans les Membres Correspondants de l'OIML

P 9 (1992) .... 100 FRF
Guidelines for the establishment of simplified metrology regulations

P 17 (1995) .... 300 FRF
Guide to the expression of uncertainty in measurement
Guide pour l'expression de l'incertitude de mesure

Measurement standards and verification equipment
Étalons et équipement de vérification

D 6 (1983) .... 60 FRF
Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

D 8 (1984) .... 60 FRF
Principles concerning choice, official recognition, use and conservation of measurement standards
Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons

D 10 (1984) .... 50 FRF
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories
Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais

D 18 (1987) .... 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 23 (1993) .... 80 FRF
Principles of metrological control of equipment used for verification
Principes du contrôle métrologique des équipements utilisés pour la vérification

P 4 (1986-*1981*) .... 100 FRF
Verification equipment for National Metrology Services
Équipement d'un Service national de métrologie

P 6 (1987) .... 100 FRF
Suppliers of verification equipment (bilingual French-English)
Fournisseurs d'équipement de vérification (bilingue français-anglais)

P 7 (1989) .... 100 FRF
Planning of metrology and testing laboratories
Planification de laboratoires de métrologie et d'essais

P 15 (1989) .... 100 FRF
Guide to calibration

Mass and density
Masses et masses volumiques

R 15 (1974-*1970*) .... 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 22 (1975) .... 150 FRF
International alcoholometric tables (trilingual French-English-Spanish version)
Tables alcoométriques internationales (version trilingue français-anglais-espagnol)

R 33 (1979-*1973*) .... 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 44 (1985) .... 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie

R 47 (1979-*1978*) .... 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 50-1 (1997) .... 150 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande) Partie 1: Exigences métrologiques et techniques - Essais

R 50-2 (1997) .... 200 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 2: Test report format
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande) Partie 2: Format du rapport d'essai

R 51-1 (1996) .... 100 FRF
Automatic catchweighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 51-2 (1996) .... 300 FRF
Automatic catchweighing instruments. Part 2: Test report format
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 52 (1980) .... 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 60 (1991) .... 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée

Annex (1993) .... 80 FRF
Test report format for the evaluation of load cells
Format du rapport d'essai des cellules de pesée

R 61-1 (1996) .... 150 FRF
Automatic gravimetric filling instruments. Part 1: Metrological and technical requirements - Tests
Doseuses pondérales à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 61-2 (1996) .... 250 FRF
Automatic gravimetric filling instruments.
Part 2: Test report format
Doseuses pondérales à fonctionnement automatique.
Partie 2: Format du rapport d'essai

R 74 (1993) .... 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 76-1 (1992) .... 300 FRF
Nonautomatic weighing instruments. Part 1:
Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique.
Partie 1: Exigences métrologiques et techniques - Essais
Amendment No. 1 (1994) .... NC

R 76-2 (1993) .... 200 FRF
Nonautomatic weighing instruments.
Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique.
Partie 2: Rapport d'essai de modèle
Amendment No. 1 (1995) .... NC

R 106-1 (1997) .... 150 FRF
Automatic rail-weighbridges. Part 1:
Metrological and technical requirements - Tests
Ponts-bascules ferroviaires à fonctionnement automatique.
Partie 1: Exigences métrologiques et techniques - Essais

R 106-2 (1997) .... 250 FRF
Automatic rail-weighbridges. Part 2: Test report format
Ponts-bascules ferroviaires à fonctionnement automatique.
Partie 2: Format du rapport d'essai

R 107-1 (1997) .... 150 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 1:
Metrological and technical requirements - Tests
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie)
Partie 1: Exigences métrologiques et techniques - Essais

R 107-2 (1997) .... 300 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers).
Part 2: Test report format
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie)
Partie 2: Format du rapport d'essai

R 111 (1994) .... 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

P 5 (1992) .... 100 FRF
Mobile equipment for the verification of road weighbridges (bilingual French-English)
Équipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 8 (1987) .... 100 FRF
Density measurement
Mesure de la masse volumique

Length and speed
Longueurs et vitesses

R 21 (1975-1973) .... 60 FRF
Taximeters
Taximètres

R 24 (1975-1973) .... 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour Agents de vérification

R 30 (1981) .... 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 35 (1985) .... 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 55 (1981) .... 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 66 (1985) .... 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 91 (1990) .... 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 98 (1991) .... 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

Liquid measurement
Mesurage des liquides

R 4 (1972-1970) .... 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 29 (1979-1973) .... 50 FRF
Capacity serving measures
Mesures de capacité de service

R 40 (1981-*1977*) .... 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour Agents de vérification

R 41 (1981-*1977*) .... 60 FRF
Standard burettes for verification officers
Burettes étalons pour Agents de vérification

R 43 (1981-*1977*) .... 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour Agents de vérification

R 45 (1980-*1977*) .... 50 FRF
Casks and barrels
Tonneaux et futailles

R 49 .... being revised - *en cours de révision*
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 63 (1994) .... 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 71 (1985) .... 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) .... 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 80 (1989) .... 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 (1998) .... 150 FRF
Dynamic measuring devices and systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure dynamique de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 85 (1998) .... 150 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 (1989) .... 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

R 95 (1990) .... 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) .... 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 105 (1993) .... 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides
Annex (1995) .... 80 FRF
Test report format
Format du rapport d'essai

R 117 (1995) .... 400 FRF
Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (1995) .... 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (1996) .... 80 FRF
Pipe provers for testing measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (1996) .... 100 FRF
Standard capacity measures for testing measuring systems for liquids other than water
Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 125 (1998) .... 100 FRF
Measuring systems for the mass of liquids in tanks
Systèmes de mesure de la masse des liquides dans les réservoirs

D 4 (1981) .... 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 7 (1984) .... 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Évaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

D 25 (1996) .... 60 FRF
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 .... being printed - *en cours de publication*
Glass delivery measures – Automatic pipettes
Mesures en verre à délivrer – Pipettes automatiques

Gas measurement (1)
Mesurage des gaz

R 6 (1989) .... 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 31 (1995) .... 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) .... 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

Pressure (2)
Pressions

R 23 (1975–*1973*) .... 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

R 53 (1982) .... 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure.
Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression.
Méthodes de leur détermination

R 97 (1990) .... 60 FRF
Barometers
Baromètres

R 101 (1991) .... 80 FRF
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 109 (1993) .... 60 FRF
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) .... 80 FRF
Pressure balances
Manomètres à piston

Temperature (2)
Températures

R 18 (1989) .... 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 48 (1980–*1978*) .... 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

R 75 (1988) .... 60 FRF
Heat meters
Compteurs d'énergie thermique

R 84 (1989) .... 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

D 24 (1996) .... 60 FRF
Total radiation pyrometers
Pyromètres à radiation totale

P 16 (1991) .... 100 FRF
Guide to practical temperature measurements

Electricity
Électricité

R 46 .... being revised - *en cours de révision*
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

(1) See also "Liquid measurement" D 25 – *Voir aussi "Mesurage des liquides" D 25*
(2) See also "Medical instruments" – *Voir aussi "Instruments médicaux"*

D 11 (1994) .... 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

Acoustics and vibration (1)
Acoustique et vibrations

R 58 (1998) .... 80 FRF
Sound level meters
Sonomètres

R 88 (1998) .... 80 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 102 (1992) .... 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (1995) .... 80 FRF
Test methods for pattern evaluation and test report format
Méthodes d'essai de modèle et format du rapport d'essai

R 103 (1992) .... 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) .... 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

Annex F (1997) .... 100 FRF
Test report format
Format du rapport d'essai

Environment
Environnement

R 82 (1989) .... 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) .... 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 99 (1998) .... 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) .... 80 FRF
Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 112 (1994) .... 80 FRF
High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) .... 80 FRF
Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 116 (1995) .... 80 FRF
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau

R 123 (1997) .... 100 FRF
Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux

D 22 (1991) .... 80 FRF
Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

Physico-chemical measurements
Mesures physico-chimiques

R 14 (1995) .... 60 FRF
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 54 .... being revised - *en cours de révision*
pH scale for aqueous solutions
Échelle de pH des solutions aqueuses

R 56 (1981) .... 50 FRF
Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 59 (1984) .... 80 FRF
Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 68 (1985) .... 50 FRF
Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) .... 50 FRF
Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) .... 50 FRF
Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 73 (1985) .... 50 FRF
Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 92 (1989) .... 60 FRF
Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 108 (1993) .... 60 FRF
Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 121 (1996) .... 60 FRF
The scale of relative humidity of air certified against saturated salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

R 124 (1997) .... 80 FRF
Refractometers for the measurement of the sugar content of grape must
Réfractomètres pour la mesure de la teneur en sucre des moûts de raisin

R 126 (1998) .... 150 FRF
Evidential breath analyzers
Éthylomètres

D 17 (1987) .... 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

Medical instruments
Instruments médicaux

R 7 (1979–*1978*) .... 60 FRF
Clinical thermometers, mercury-in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 16 (1973–*1970*) .... 50 FRF
Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 26 (1978–*1973*) .... 50 FRF
Medical syringes
Seringues médicales

R 78 (1989) .... 50 FRF
Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

R 89 (1990) .... 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Électroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 (1990) .... 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Électrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 93 (1990) .... 60 FRF
Focimeters
Frontofocomètres

R 114 (1995) .... 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) .... 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 122 (1996) .... 60 FRF
Equipment for speech audiometry
Appareils pour l'audiométrie vocale

D 21 (1990) .... 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

Testing of materials
Essais des matériaux

R 9 (1972–*1970*) .... 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974–*1970*) .... 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974–*1970*) .... 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974–*1970*) .... 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 36 (1980–*1977*) .... 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T - C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T -C,A,N)

R 62 (1985) .... 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 64 (1985) .... 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) .... 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

V 3 (1991) .... 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

P 10 (1981) .... 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) .... 100 FRF
Factors influencing hardness measurement

P 12 (1984) .... 100 FRF
Hardness test blocks and indenters

P 13 (1989) .... 100 FRF
Hardness standard equipment

P 14 (1991) .... 100 FRF
The unification of hardness measurement

Prepackaging
Préemballages

R 79 (1997) .... 60 FRF
Labeling requirements for prepackaged products
Exigences pour l'étiquetage des produits préemballés

R 87 (1989) .... 50 FRF
Net content in packages
Contenu net des préemballages

INTERNATIONAL RECOMMENDATIONS
RECOMMANDATIONS INTERNATIONALES

R 4 (1970–*1972*) .... 50 FRF
Volumetric flasks (one mark) in glass
Fioles jaugées à un trait en verre

R 6 (1989) .... 80 FRF
General provisions for gas volume meters
Dispositions générales pour les compteurs de volume de gaz

R 7 (1979–*1978*) .... 60 FRF
Clinical thermometers, mercury-in-glass with maximum device
Thermomètres médicaux à mercure, en verre, avec dispositif à maximum

R 9 (1972–*1970*) .... 60 FRF
Verification and calibration of Brinell hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Brinell

R 10 (1974–*1970*) .... 60 FRF
Verification and calibration of Vickers hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Vickers

R 11 (1974–*1970*) .... 60 FRF
Verification and calibration of Rockwell B hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell B

R 12 (1974–*1970*) .... 60 FRF
Verification and calibration of Rockwell C hardness standardized blocks
Vérification et étalonnage des blocs de référence de dureté Rockwell C

R 14 (1995) .... 60 FRF
Polarimetric saccharimeters
Saccharimètres polarimétriques

R 15 (1974–*1970*) .... 80 FRF
Instruments for measuring the hectolitre mass of cereals
Instruments de mesure de la masse à l'hectolitre des céréales

R 16 (1973–*1970*) .... 50 FRF
Manometers for instruments for measuring blood pressure (sphygmomanometers)
Manomètres des instruments de mesure de la tension artérielle (sphygmomanomètres)

R 18 (1989) .... 60 FRF
Visual disappearing filament pyrometers
Pyromètres optiques à filament disparaissant

R 21 (1975–*1973*) .... 60 FRF
Taximeters
Taximètres

R 22 (1975–*1973*) .... 150 FRF
International alcoholometric tables (trilingual French-English-Spanish)
Tables alcoométriques internationales (trilingue français-anglais-espagnol)

R 23 (1975–*1973*) .... 60 FRF
Tyre pressure gauges for motor vehicles
Manomètres pour pneumatiques de véhicules automobiles

R 24 (1975–*1973*) .... 50 FRF
Standard one metre bar for verification officers
Mètre étalon rigide pour agents de vérification

R 26 (1978–*1973*) .... 50 FRF
Medical syringes
Seringues médicales

R 29 (1979–*1973*) .... 50 FRF
Capacity serving measures
Mesures de capacité de service

R 30 (1981) .... 60 FRF
End standards of length (gauge blocks)
Mesures de longueur à bouts plans (cales étalons)

R 31 (1995) .... 80 FRF
Diaphragm gas meters
Compteurs de gaz à parois déformables

R 32 (1989) .... 60 FRF
Rotary piston gas meters and turbine gas meters
Compteurs de volume de gaz à pistons rotatifs et compteurs de volume de gaz à turbine

R 33 (1979–*1973*) .... 50 FRF
Conventional value of the result of weighing in air
Valeur conventionnelle du résultat des pesées dans l'air

R 34 (1979–*1974*) .... 60 FRF
Accuracy classes of measuring instruments
Classes de précision des instruments de mesurage

R 35 (1985) .... 80 FRF
Material measures of length for general use
Mesures matérialisées de longueur pour usages généraux

R 36 (1980–*1977*) .... 60 FRF
Verification of indenters for hardness testing machines
Vérification des pénétrateurs des machines d'essai de dureté

R 37 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Brinell system)
Vérification des machines d'essai de dureté (système Brinell)

R 38 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Vickers system)
Vérification des machines d'essai de dureté (système Vickers)

R 39 (1981–*1977*) .... 60 FRF
Verification of hardness testing machines (Rockwell systems B,F,T-C,A,N)
Vérification des machines d'essai de dureté (systèmes Rockwell B,F,T-C,A,N)

R 40 (1981–*1977*) .... 60 FRF
Standard graduated pipettes for verification officers
Pipettes graduées étalons pour agents de vérification

R 41 (1981–*1977*) .... 60 FRF
Standard burettes for verification officers
Burettes étalons pour agents de vérification

R 42 (1981–*1977*) .... 50 FRF
Metal stamps for verification officers
Poinçons de métal pour agents de vérification

R 43 (1981–*1977*) .... 60 FRF
Standard graduated glass flasks for verification officers
Fioles étalons graduées en verre pour agents de vérification

R 44 (1985) .... 50 FRF
Alcoholometers and alcohol hydrometers and thermometers for use in alcoholometry
Alcoomètres et aréomètres pour alcool et thermomètres utilisés en alcoométrie

R 45 (1980–*1977*) .... 50 FRF
Casks and barrels
Tonneaux et futailles

R 46 .... being revised - *en cours de révision*
Active electrical energy meters for direct connection of class 2
Compteurs d'énergie électrique active à branchement direct de la classe 2

R 47 (1979–*1978*) .... 60 FRF
Standard weights for testing of high capacity weighing machines
Poids étalons pour le contrôle des instruments de pesage de portée élevée

R 48 (1980–*1978*) .... 50 FRF
Tungsten ribbon lamps for calibration of optical pyrometers
Lampes à ruban de tungstène pour l'étalonnage des pyromètres optiques

R 49 .... being revised - *en cours de révision*
Water meters intended for the metering of cold water
Compteurs d'eau destinés au mesurage de l'eau froide

R 50-1 (1997) .... 150 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs continus à fonction nement automatique (peseuses sur bande).
Partie 1: Exigences métrologiques et techniques - Essais

R 50-2 (1997) .... 200 FRF
Continuous totalizing automatic weighing instruments (Belt weighers). Part 2: Test report format
Instruments de pesage totalisateurs continus à fonctionnement automatique (peseuses sur bande).
Partie 2: Format du rapport d'essai

R 51-1 (1996) .... 100 FRF
Automatic catchweighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 51-2 (1996) .... 300 FRF
Automatic catchweighing instruments. Part 2: Test report format
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 52 (1980) .... 50 FRF
Hexagonal weights, ordinary accuracy class from 100 g to 50 kg
Poids hexagonaux de classe de précision ordinaire, de 100 g à 50 kg

R 53 (1982) .... 60 FRF
Metrological characteristics of elastic sensing elements used for measurement of pressure. Determination methods
Caractéristiques métrologiques des éléments récepteurs élastiques utilisés pour le mesurage de la pression. Méthodes de leur détermination

R 54 .... being revised - *en cours de révision*
pH scale for aqueous solutions
Échelle de pH des solutions aqueuses

R 55 (1981) .... 50 FRF
Speedometers, mechanical odometers and chronotachographs for motor vehicles. Metrological regulations
Compteurs de vitesse, compteurs mécaniques de distance et chronotachygraphes des véhicules automobiles. Réglementation métrologique

R 56 (1981) .... 50 FRF
Standard solutions reproducing the conductivity of electrolytes
Solutions-étalons reproduisant la conductivité des électrolytes

R 58 (1998) .... 80 FRF
Sound level meters
Sonomètres

R 59 (1984) .... 80 FRF
Moisture meters for cereal grains and oilseeds
Humidimètres pour grains de céréales et graines oléagineuses

R 60 (1991) .... 80 FRF
Metrological regulation for load cells
Réglementation métrologique des cellules de pesée
Annex (1993) .... 80 FRF
Test report format for the evaluation of load cells
Format du rapport d'essai des cellules de pesée

R 61-1 (1996) .... 150 FRF
Automatic gravimetric filling instruments.
Part 1: Metrological and test requirements - Tests
Doseuses pondérales à fonctionnement automatique.
Partie 1: Exigences métrologiques et techniques - Essais

R 61-2 (1996) .... 250 FRF
Automatic gravimetric filling instruments.
Part 2: Test report format
Doseuses pondérales à fonctionnement automatique.
Partie 2: Format du rapport d'essai

R 62 (1985) .... 80 FRF
Performance characteristics of metallic resistance strain gauges
Caractéristiques de performance des extensomètres métalliques à résistance

R 63 (1994) .... 50 FRF
Petroleum measurement tables
Tables de mesure du pétrole

R 64 (1985) .... 50 FRF
General requirements for materials testing machines
Exigences générales pour les machines d'essai des matériaux

R 65 (1985) .... 60 FRF
Requirements for machines for tension and compression testing of materials
Exigences pour les machines d'essai des matériaux en traction et en compression

R 66 (1985) .... 60 FRF
Length measuring instruments
Instruments mesureurs de longueurs

R 68 (1985) .... 50 FRF
Calibration method for conductivity cells
Méthode d'étalonnage des cellules de conductivité

R 69 (1985) .... 50 FRF
Glass capillary viscometers for the measurement of kinematic viscosity. Verification method
Viscosimètres à capillaire, en verre, pour la mesure de la viscosité cinématique. Méthode de vérification

R 70 (1985) .... 50 FRF
Determination of intrinsic and hysteresis errors of gas analysers
Détermination des erreurs de base et d'hystérésis des analyseurs de gaz

R 71 (1985) .... 80 FRF
Fixed storage tanks. General requirements
Réservoirs de stockage fixes. Prescriptions générales

R 72 (1985) .... 60 FRF
Hot water meters
Compteurs d'eau destinés au mesurage de l'eau chaude

R 73 (1985) .... 50 FRF
Requirements concerning pure gases CO, CO_2, CH_4, H_2, O_2, N_2 and Ar intended for the preparation of reference gas mixtures
Prescriptions pour les gaz purs CO, CO_2, CH_4, H_2, O_2, N_2 et Ar destinés à la préparation des mélanges de gaz de référence

R 74 (1993) .... 80 FRF
Electronic weighing instruments
Instruments de pesage électroniques

R 75 (1988) .... 60 FRF
Heat meters
Compteurs d'énergie thermique

R 76-1 (1992) .... 300 FRF
Nonautomatic weighing instruments. Part 1: Metrological and technical requirements - Tests
Instruments de pesage à fonctionnement non automatique.
Partie 1: Exigences métrologiques et techniques - Essais
Amendment No. 1 (1994) .... NC

R 76-2 (1993) .... 200 FRF
Nonautomatic weighing instruments.
Part 2: Pattern evaluation report
Instruments de pesage à fonctionnement non automatique.
Partie 2: Rapport d'essai de modèle
Amendment No. 1 (1995) .... NC

R 78 (1989) .... 50 FRF
Westergren tubes for measurement of erythrocyte sedimentation rate
Pipettes Westergren pour la mesure de la vitesse de sédimentation des hématies

R 79 (1997) .... 60 FRF
Labeling requirements for prepackaged products
Exigences pour l'étiquetage des produits préemballés

R 80 (1989) .... 100 FRF
Road and rail tankers
Camions et wagons-citernes

R 81 (1998) .... 150 FRF
Dynamic measuring devices and systems for cryogenic liquids (including tables of density for liquid argon, helium, hydrogen, nitrogen and oxygen)
Dispositifs et systèmes de mesure dynamique de liquides cryogéniques (comprend tables de masse volumique pour argon, hélium, hydrogène, azote et oxygène liquides)

R 82 (1989) .... 80 FRF
Gas chromatographs for measuring pollution from pesticides and other toxic substances
Chromatographes en phase gazeuse pour la mesure des pollutions par pesticides et autres substances toxiques

R 83 (1990) .... 80 FRF
Gas chromatograph/mass spectrometer/data system for analysis of organic pollutants in water
Chromatographe en phase gazeuse équipé d'un spectromètre de masse et d'un système de traitement de données pour l'analyse des polluants organiques dans l'eau

R 84 (1989) .... 60 FRF
Resistance-thermometer sensors made of platinum, copper or nickel (for industrial and commercial use)
Capteurs à résistance thermométrique de platine, de cuivre ou de nickel (à usages techniques et commerciaux)

R 85 (1998) .... 150 FRF
Automatic level gauges for measuring the level of liquid in fixed storage tanks
Jaugeurs automatiques pour le mesurage des niveaux de liquide dans les réservoirs de stockage fixes

R 86 (1989) .... 50 FRF
Drum meters for alcohol and their supplementary devices
Compteurs à tambour pour alcool et leurs dispositifs complémentaires

R 87 (1989) .... 50 FRF
Net content in packages
Contenu net des préemballages

R 88 (1998) .... 80 FRF
Integrating-averaging sound level meters
Sonomètres intégrateurs-moyenneurs

R 89 (1990) .... 80 FRF
Electroencephalographs - Metrological characteristics - Methods and equipment for verification
Électroencéphalographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 90 (1990) .... 80 FRF
Electrocardiographs - Metrological characteristics - Methods and equipment for verification
Électrocardiographes - Caractéristiques métrologiques - Méthodes et moyens de vérification

R 91 (1990) .... 60 FRF
Radar equipment for the measurement of the speed of vehicles
Cinémomètres radar pour la mesure de la vitesse des véhicules

R 92 (1989) .... 60 FRF
Wood-moisture meters - Verification methods and equipment: general provisions
Humidimètres pour le bois - Méthodes et moyens de vérification: exigences générales

R 93 (1990) .... 60 FRF
Focimeters
Frontofocomètres

R 95 (1990) .... 60 FRF
Ships' tanks - General requirements
Bateaux-citernes - Prescriptions générales

R 96 (1990) .... 50 FRF
Measuring container bottles
Bouteilles récipients-mesures

R 97 (1990) .... 60 FRF
Barometers
Baromètres

R 98 (1991) .... 60 FRF
High-precision line measures of length
Mesures matérialisées de longueur à traits de haute précision

R 99 (1998) .... 100 FRF
Instruments for measuring vehicle exhaust emissions
Instruments de mesure des gaz d'échappement des véhicules

R 100 (1991) .... 80 FRF
Atomic absorption spectrometers for measuring metal pollutants in water
Spectromètres d'absorption atomique pour la mesure des polluants métalliques dans l'eau

R 101 (1991) .... 80 FRF
Indicating and recording pressure gauges, vacuum gauges and pressure vacuum gauges with elastic sensing elements (ordinary instruments)
Manomètres, vacuomètres et manovacuomètres indicateurs et enregistreurs à élément récepteur élastique (instruments usuels)

R 102 (1992) .... 50 FRF
Sound calibrators
Calibreurs acoustiques

Annex (1995) .... 80 FRF
Test methods for pattern evaluation and test report format
Méthodes d'essai de modèle et format du rapport d'essai

R 103 (1992) .... 60 FRF
Measuring instrumentation for human response to vibration
Appareillage de mesure pour la réponse des individus aux vibrations

R 104 (1993) .... 60 FRF
Pure-tone audiometers
Audiomètres à sons purs

Annex F (1997) .... 100 FRF
Test report format
Format du rapport d'essai

R 105 (1993) .... 100 FRF
Direct mass flow measuring systems for quantities of liquids
Ensembles de mesurage massiques directs de quantités de liquides

Annex (1995) .... 80 FRF
Test report format
Format du rapport d'essai

R 106-1 (1997) .... 150 FRF
Automatic rail-weighbridges. Part 1: Metrological and technical requirements - Tests
Ponts-bascules ferroviaires à fonctionnement automatique. Partie 1: Exigences métrologiques et techniques - Essais

R 106-2 (1997) .... 250 FRF
Automatic rail-weighbridges. Part 2: Test report format
Ponts-bascules ferroviaires à fonctionnement automatique. Partie 2: Format du rapport d'essai

R 107-1 (1997) .... 150 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 1: Metrological and technical requirements - Tests
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie). Partie 1: Exigences métrologiques et techniques - Essais

R 107-2 (1997) .... 300 FRF
Discontinuous totalizing automatic weighing instruments (totalizing hopper weighers). Part 2: Test report format
Instruments de pesage totalisateurs discontinus à fonctionnement automatique (peseuses totalisatrices à trémie). Partie 2: Format du rapport d'essai

R 108 (1993) .... 60 FRF
Refractometers for the measurement of the sugar content of fruit juices
Réfractomètres pour la mesure de la teneur en sucre des jus de fruits

R 109 (1993) .... 60 FRF
Pressure gauges and vacuum gauges with elastic sensing elements (standard instruments)
Manomètres et vacuomètres à élément récepteur élastique (instruments étalons)

R 110 (1994) .... 80 FRF
Pressure balances
Manomètres à piston

R 111 (1994) .... 80 FRF
Weights of classes E_1, E_2, F_1, F_2, M_1, M_2, M_3
Poids des classes E_1, E_2, F_1, F_2, M_1, M_2, M_3

R 112 (1994) .... 80 FRF
High performance liquid chromatographs for measurement of pesticides and other toxic substances
Chromatographes en phase liquide de haute performance pour la mesure des pesticides et autres substances toxiques

R 113 (1994) .... 80 FRF
Portable gas chromatographs for field measurements of hazardous chemical pollutants
Chromatographes en phase gazeuse portatifs pour la mesure sur site des polluants chimiques dangereux

R 114 (1995) .... 80 FRF
Clinical electrical thermometers for continuous measurement
Thermomètres électriques médicaux pour mesurage en continu

R 115 (1995) .... 80 FRF
Clinical electrical thermometers with maximum device
Thermomètres électriques médicaux avec dispositif à maximum

R 116 (1995) .... 80 FRF
Inductively coupled plasma atomic emission spectrometers for measurement of metal pollutants in water
Spectromètres à émission atomique de plasma couplé inductivement pour le mesurage des polluants métalliques dans l'eau

R 117 (1995) .... 400 FRF
Measuring systems for liquids other than water
Ensembles de mesurage de liquides autres que l'eau

R 118 (1995) .... 100 FRF
Testing procedures and test report format for pattern evaluation of fuel dispensers for motor vehicles
Procédures d'essai et format du rapport d'essai des modèles de distributeurs de carburant pour véhicules à moteur

R 119 (1996) .... 80 FRF
Pipe provers for testing measuring systems for liquids other than water
Tubes étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 120 (1996) .... 100 FRF
Standard capacity measures for testing measuring systems for liquids other than water
Mesures de capacité étalons pour l'essai des ensembles de mesurage de liquides autres que l'eau

R 121 (1996) .... 60 FRF
The scale of relative humidity of air certified against saturated salt solutions
Échelle d'humidité relative de l'air certifiée par rapport à des solutions saturées de sels

R 122 (1996) .... 60 FRF
Equipment for speech audiometry
Appareils pour l'audiométrie vocale

R 123 (1997) .... 100 FRF
Portable and transportable X-ray fluorescence spectrometers for field measurement of hazardous elemental pollutants
Spectromètres à fluorescence de rayons X portatifs et déplaçables pour la mesure sur le terrain d'éléments polluants dangereux

R 124 (1997) .... 80 FRF
Refractometers for the measurement of the sugar content of grape must
Réfractomètres pour la mesure de la teneur en sucre des moûts de raisin

R 125 (1998) .... 100 FRF
Measuring systems for the mass of liquids in tanks
Systèmes de mesure de la masse des liquides dans les réservoirs

R 126 (1998) .... 150 FRF
Evidential breath analyzers
Éthylomètres

INTERNATIONAL DOCUMENTS
DOCUMENTS INTERNATIONAUX

D 1 (1975) .... 50 FRF
Law on metrology
Loi de métrologie

D 2 (1998) .... 80 FRF
Legal units of measurement
Unités de mesure légales

D 3 (1979) .... 60 FRF
Legal qualification of measuring instruments
Qualification légale des instruments de mesurage

D 4 (1981) .... 50 FRF
Installation and storage conditions for cold water meters
Conditions d'installation et de stockage des compteurs d'eau froide

D 5 (1982) .... 60 FRF
Principles for the establishment of hierarchy schemes for measuring instruments
Principes pour l'établissement des schémas de hiérarchie des instruments de mesure

D 6 (1983) .... 60 FRF
Documentation for measurement standards and calibration devices
Documentation pour les étalons et les dispositifs d'étalonnage

D 7 (1984) .... 80 FRF
The evaluation of flow standards and facilities used for testing water meters
Évaluation des étalons de débitmétrie et des dispositifs utilisés pour l'essai des compteurs d'eau

D 8 (1984) .... 60 FRF
Principles concerning choice, official recognition, use and conservation of measurement standards
Principes concernant le choix, la reconnaissance officielle, l'utilisation et la conservation des étalons

D 9 (1984) .... 60 FRF
Principles of metrological supervision
Principes de la surveillance métrologique

D 10 (1984) .... 50 FRF
Guidelines for the determination of recalibration intervals of measuring equipment used in testing laboratories
Conseils pour la détermination des intervalles de réétalonnage des équipements de mesure utilisés dans les laboratoires d'essais

D 11 (1994) .... 80 FRF
General requirements for electronic measuring instruments
Exigences générales pour les instruments de mesure électroniques

D 12 (1986) .... 50 FRF
Fields of use of measuring instruments subject to verification
Domaines d'utilisation des instruments de mesure assujettis à la vérification

D 13 (1986) .... 50 FRF
Guidelines for bi- or multilateral arrangements on the recognition of: test results - pattern approvals - verifications
Conseils pour les arrangements bi- ou multilatéraux de reconnaissance des: résultats d'essais - approbations de modèles - vérifications

D 14 (1989) .... 60 FRF
Training of legal metrology personnel - Qualification - Training programs
Formation du personnel en métrologie légale - Qualification - Programmes d'étude

D 15 (1986) .... 80 FRF
Principles of selection of characteristics for the examination of measuring instruments
Principes du choix des caractéristiques pour l'examen des instruments de mesure usuels

D 16 (1986) .... 80 FRF
Principles of assurance of metrological control
Principes d'assurance du contrôle métrologique

D 17 (1987) .... 50 FRF
Hierarchy scheme for instruments measuring the viscosity of liquids
Schéma de hiérarchie des instruments de mesure de la viscosité des liquides

D 18 (1987) .... 50 FRF
General principles of the use of certified reference materials in measurements
Principes généraux d'utilisation des matériaux de référence certifiés dans les mesurages

D 19 (1988) .... 80 FRF
Pattern evaluation and pattern approval
Essai de modèle et approbation de modèle

D 20 (1988) .... 80 FRF
Initial and subsequent verification of measuring instruments and processes
Vérifications primitive et ultérieure des instruments et processus de mesure

D 21 (1990) .... 80 FRF
Secondary standard dosimetry laboratories for the calibration of dosimeters used in radiotherapy
Laboratoires secondaires d'étalonnage en dosimétrie pour l'étalonnage des dosimètres utilisés en radiothérapie

D 22 (1991) .... 80 FRF
Guide to portable instruments for assessing airborne pollutants arising from hazardous wastes
Guide sur les instruments portatifs pour l'évaluation des polluants contenus dans l'air en provenance des sites de décharge de déchets dangereux

D 23 (1993) .... 80 FRF
Principles of metrological control of equipment used for verification
Principes du contrôle métrologique des équipements utilisés pour la vérification

D 24 (1996) .... 60 FRF
Total radiation pyrometers
Pyromètres à radiation totale

D 25 (1996) .... 60 FRF
Vortex meters used in measuring systems for fluids
Compteurs à vortex utilisés dans les ensembles de mesurage de fluides

D 26 .... being printed - *en cours de publication*
Glass delivery measures - Automatic pipettes
Mesures en verre à délivrer - Pipettes automatiques

VOCABULARIES
VOCABULAIRES

V 1 (1978) .... 100 FRF
Vocabulary of legal metrology (bilingual French-English)
Vocabulaire de métrologie légale (bilingue français-anglais)

V 2 (1993) .... 200 FRF
International vocabulary of basic and general terms in metrology (bilingual French-English)
Vocabulaire international des termes fondamentaux et généraux de métrologie (bilingue français-anglais)

V 3 (1991) .... 80 FRF
Hardness testing dictionary (quadrilingual French-English-German-Russian)
Dictionnaire des essais de dureté (quadrilingue français-anglais-allemand-russe)

OTHER PUBLICATIONS
AUTRES PUBLICATIONS

P 1 (1991) .... 60 FRF
OIML Certificate System for Measuring Instruments
Système de Certificats OIML pour les Instruments de Mesure

P 2 (1987) .... 100 FRF
Metrology training - Synthesis and bibliography (bilingual French-English)
Formation en métrologie - Synthèse et bibliographie (bilingue français-anglais)

P 3-1 (1996) .... 400 FRF
Legal metrology in OIML Member States
Métrologie légale dans les États Membres de l'OIML

P 3-2 (1996) .... 300 FRF
Legal metrology in OIML Corresponding Members
Métrologie légale dans les Membres Correspondants de l'OIML

P 4 (1986–*1981*) .... 100 FRF
Verification equipment for National Metrology Services
Équipement d'un Service national de métrologie

P 5 (1992) .... 100 FRF
Mobile equipment for the verification of road weighbridges (bilingual French- English)
Équipement mobile pour la vérification des ponts-bascules routiers (bilingue français-anglais)

P 6 (1987) .... 100 FRF
Suppliers of verification equipment (bilingual French-English)
Fournisseurs d'équipement de vérification (bilingue français-anglais)

P 7 (1989) .... 100 FRF
Planning of metrology and testing laboratories
Planification de laboratoires de métrologie et d'essais

P 8 (1987) .... 100 FRF
Density measurement
Mesure de la masse volumique

P 9 (1992) .... 100 FRF
Guidelines for the establishment of simplified metrology regulations

P 10 (1981) .... 50 FRF
The metrology of hardness scales - Bibliography

P 11 (1983) .... 100 FRF
Factors influencing hardness measurement

P 12 (1984) .... 100 FRF
Hardness test blocks and indenters

P 13 (1989) .... 100 FRF
Hardness standard equipment

P 14 (1991) .... 100 FRF
The unification of hardness measurement

P 15 (1989) .... 100 FRF
Guide to calibration

P 16 (1991) .... 100 FRF
Guide to practical temperature measurements

P 17 (1995) .... 300 FRF
Guide to the expression of uncertainty in measurement
Guide pour l'expression de l'incertitude de mesure

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The **OIML Bulletin** is a forum for the publication of technical papers and diverse articles addressing metrological advances in trade, health, environment and safety – fields in which the credibility of measurement remains a challenging priority. The Editors of the Bulletin encourage the submission of articles covering topics such as national, regional and international activities in metrology and related fields, evaluation procedures, accreditation and certification, and measuring techniques and instrumentation.

Authors are requested to submit a titled, typed manuscript together with the originals of any relevant visual materials (photos, illustrations, slides, etc.), together with a disk copy in one of the following formats: WordPerfect, Word 6 or 7 (or previous versions for PC or Macintosh), or Quark XPress for Macintosh. Authors are also requested to send a passport-size, black and white identity photo suitable for publication.

Papers selected for publication will be remunerated at the rate of 150 FRF per printed page, provided that they have not already been published in other journals. The Editors reserve the right to edit contributions for style and space restrictions.

Please send submissions to:

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